Engineering

January 26, 1922

Engineering News-Record

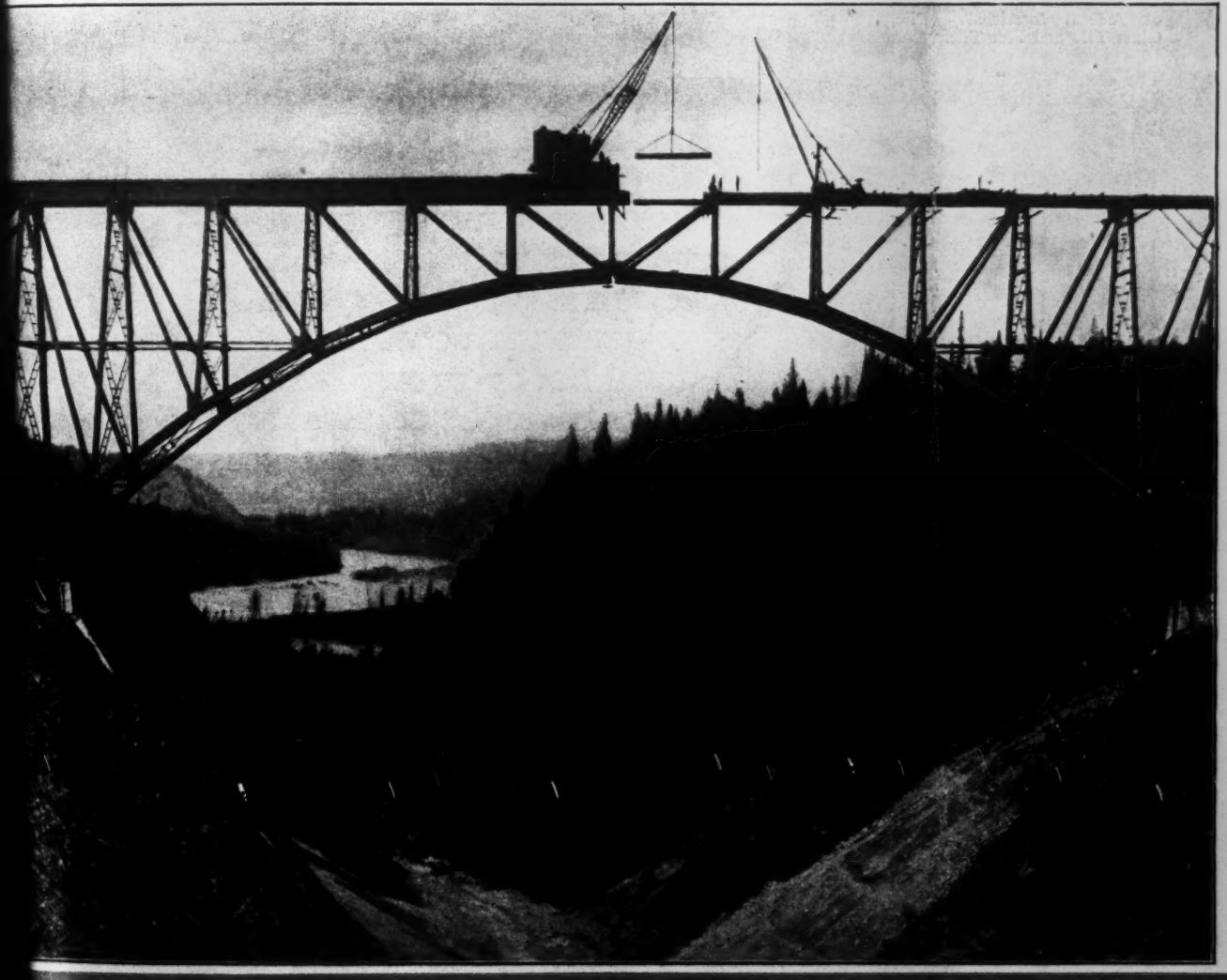
Devoted to Civil Engineering and Contracting
McGraw-Hill Co., Inc.

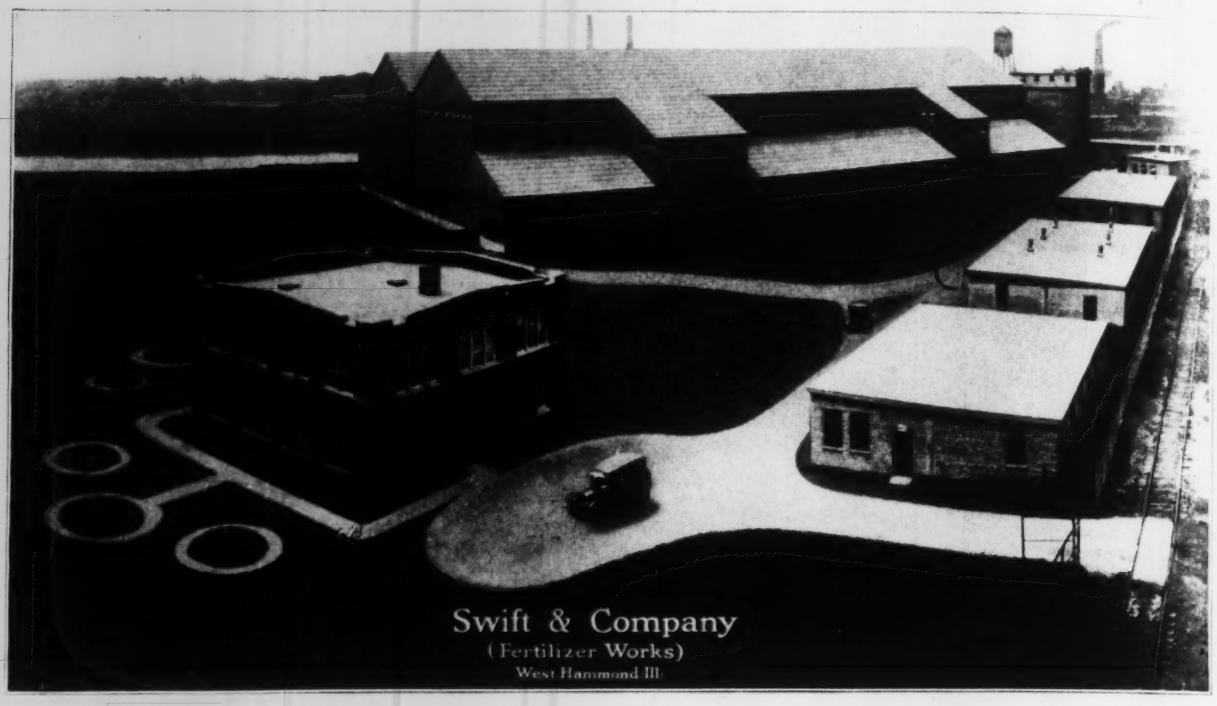
Road Builders' Convention and Road Show at Chicago

Problems of Erection of a 384-Ft. Steel Arch in Alaska

A Dozen Short "How To Do It" Articles From the Job and the Office

Putting in Place the Last Chord on the Hurricane Gulch Arch of the Alaskan Railway





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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

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A Bouquet

SOMEONE deserves a bouquet. At last week's meeting of the American Society of Civil Engineers the members were decorated with large badges carrying their names in letters so large that they could be read easily at a distance of five or six feet. This promotes acquaintance. We know many engineers by name and are glad of an opportunity to meet them, provided we do not have to kiss them before being able to decipher the name as was the case with the older badges. The new badge was a happy thought.

Am. Soc. C. E. Technical Sessions

LAST week's annual meeting of the American Society of Civil Engineers brought with it an innovation—the technical sessions. Heretofore, the program has consisted of a business session, of excursions, the president's reception and the smoker. Considering the circumstances, this first attempt had at least sufficient success to warrant trying it again next year. The attendance at the technical meetings was fairly good, and would have been better but for very apparent competition. On Thursday, excursions were offered as alternatives to the sessions. On Friday, when highway problems were under discussion, the competition was 900 miles away, in the form of the convention of the American Road Builders Association. Considering these competitive features, the attendance at the technical sessions was encouraging, and warrants further trial of the plan.

Road Building As a Great Industry

AMPLE evidence was furnished at last week's convention in Chicago of the American Road Builders Association to support the claim that highway construction has developed into one of the nation's great industries. As Webster defines it, an industry is "any department or branch of art, occupation or business, especially one which employs much labor and capital and is a distinct branch of trade." Road-building, today, clearly meets these specifications. While the professional side of the field—design, construction, and research—was by no means neglected at the meeting, the outstanding features of the technical sessions had a clearly defined financial and business slant, while the Good Roads Show, requiring the entire floor and gallery space in the Coliseum, in addition to its Annex and two other adjoining buildings rented for the occasion offered to engineer and contractor the products of 185 manufacturers representing the greatest and most diversified aggregation of road-building equipment ever before assembled at one time. It was a distinct commercial triumph. Many people still think of road building as nothing more than a pick-and-shovel job whose chief requirement is a plentiful supply of common labor. Such impressive demonstrations as last week's Good Roads Show quickly change this conception. This year's road-building program, according to figures cited by Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, will involve an expenditure of $720,000,000 outside of city limits, while last year's expenditures amounted to $600,000,000. Operations have reached such a tremendous scale that mechanical plant of great diversity and, in many instances, of enormous size and weight has been developed. The building of a modern road, therefore, is not confined to construction operations in the field. As a necessary part of these activities manufacturers have built up a great industrial organization whose service consists in supplying machinery to speed progress and reduce costs. Thus the army of labor involved in road building is now organized in two great divisions, one in the factory and the other on the work of actual construction.

Road Plant Selection

THE Good Roads Show, with its aisles flanked by ponderous paving mixers, rugged excavating equipment, highly developed material-handling plant and transportation units in the form of motor trucks, industrial locomotives, and tractors, represented an investment, in manufacturing facilities, of many millions of dollars. It served to indicate, as nothing else could have done, the broad service which the manufacturer offers to the contractor—and the financial pitfalls which contractors may encounter by failing to exercise a nice discrimination in the selection of the type and quantity of mechanical plant best suited to their particular work. The farsighted manufacturer—the man who is looking ahead to the development of the road-building industry along sound lines—will keep this point clearly in mind in his sales promotion work. Efforts merely to sell the maximum volume of construction equipment, without regard to the particular needs of the individual purchaser, will, in the end, defeat their own purpose.

The Highway's Business Side

THE business side of road construction was reflected elsewhere than in the exhibits of construction plant at Chicago. Much of the time at the technical sessions was devoted to matters of highway finance and administration. During recent years great sums have been made available for road construction, and engineers have concerned themselves mainly with the conversion of these funds into improved roads. Now, however, highway officials are exhibiting a desire for a closer scrutiny and analysis of the various sources of revenue for road-building. Throughout the country the indications are pretty clear that the general taxpayer is carrying about as heavy a load as he may reasonably be expected to shoulder. On the other hand, as was emphasized at the convention, the state highway department organizations have been geared up to handle construction programs which involve a greater outlay each year. This work cannot be prosecuted economically by

spasmodic spurts followed by periods of comparative idleness. Steady, uniform progress is essential, and it is necessary that the supply of funds shall be sufficient to maintain these operations on the large scale to which they have now been built up. The impression left by a discussion of this general subject at the convention was that there is in prospect a readjustment of the sources of highway revenue and that transportation may have to assume a larger share of the cost than it has carried in the past. In any event highway financing promises to outrank in importance any other subject in the field, for road-building, as a national industry, has "arrived."

Organized Contracting Makes Progress

CONFIDENCE in the ability of organized contracting to serve the construction industry is strengthened by the policies announced and the program of action laid down by the Associated General Contractors at their annual convention held last week in Cleveland. As summarized in the news section of this issue, the convention work developed along four general lines: Improvement of the ethics of contracting practice; standardization of construction procedure and contractual relations; improvement of business methods, and co-operation with government departments and organized engineering in stabilizing the construction industry. The progress accomplished and the performance promised are not equal in all directions and this more than any other thing indicated that organized contracting has not fully allocated its responsibilities. Not perceiving its way clearly, it is temporizing.

Lack of determination is most evident in the convention action on the situation disclosed by the legislative investigations of construction and contracting in New York and Chicago. Some more virile and positive action than an expression of sympathy with the "purpose" of these investigations seems required and should have been confidently expected by the building public. It does not meet the situation to declare that no member of the association has been convicted of complicity or to exhort all members to adhere to honest practices. Responsibility cannot be evaded by changing names from contractor to constructor or by drawing distinctions between general contracting and the contracting trade. The building public will not accept fine distinctions as a substitute for the drastic housecleaning which is needed in many branches of the contracting business. The Associated General Contractors at Cleveland were looked to for a program of constructive effort to eradicate questionable practices of the sort disclosed by the Lockwood and Daily investigations and they failed to satisfy anticipations.

This disposition to temporize with bad conditions is all the more surprising when is contemplated the vigorous disciplinary action which the convention took governing the procedure of contractors operating outside their home territory. In this situation, one of great danger to the harmony of the contracting business, the convention acted with admirable promptitude and vigor. The action binds the constituent chapters of the association into a stronger general body and does much toward stabilizing the labor situation.

Another indication of the disposition of organized contracting to reconstruct its business is found in the program laid down for standardizing construction methods and equipment and developing generally the technique of construction. This is not a task which will be accomplished in a year or even in several years but it needs to be prosecuted with all the energy that can be brought to bear so that contracting can without challenge assert its supremacy in skill in constructing.

Collaboration was set forth by the convention proceedings as, finally, the great duty of associated contractors. During the year which has just passed, this has been an outstanding feature of association work. It will be extended during the present year. This policy of reaching out into the work of solving the problems of associated industries offers perhaps greater promise of the ultimate success of organized contracting than any other accomplishment of its brief life of three years. The association has over a thousand members, its membership now represents probably 80 per cent of the capital invested in general contracting and it has a budget of $175,000 for its year's work, it therefore has a power for co-operation with which organized engineering should in turn enlist itself.

Paying for the St. Lawrence

IN ITS complete form the report of the International Joint Commission on the projected St. Lawrence waterway will be a formidable volume. The advance galleys of the report—minus the appendices—which have just come to this office promise many hours of solid reading for an understanding. One thing, however, stands out from the recommendations which were printed in these columns last week and which are elaborated in the report; the cost of the project as proposed by the commission will weigh much more heavily on the United States than on Canada. The 50-50 proposition heretofore considered is far from being realized.

The commission quite clearly believes in the proposed improvement. It recommends definitely a treaty between the two countries to carry it out and equally definitely sets down the principle that each country should assume first cost, maintenance and operation charges for the power developments, which will lie in the respective national domains.

Navigation works costs are not so definitely apportioned. On the principle that each country should pay according to benefits, the costs during the "construction period," which lasts until five years after completion, are to be "determined upon certain known factors such as the developed resources and foreign and coastwise trade of each country within the territory economically tributary to the proposed waterway." Thereafter, the ratio is to be adjusted upon the freight tonnage of each country actually using the waterway. Assuming it possible to come to an understanding as to the "factors" referred to in the foregoing quotation, it is obvious that the first cost of the navigation works will be borne mostly by the United States—and this includes the cost of the Welland canal and of the projected lower canals all lying wholly in Canadian territory. Any subsequent adjustment on the basis of tonnage moved apparently will affect only operation and maintenance charges—a small percentage of the first cost which is assessed mainly against this country.

In the Wooten-Bowden estimate roughly $140,000,000 is for power and $112,000,000 for navigation. According to the recommendations of the commission, of this total the United States would pay about $160,000,000

and Canada $92,000,000, as near as can be judged from the relative economic tributaries elaborated in the report. In other words, Canada would pay for her own water power and contribute toward the navigation end just about as much as the cost of the work already done on the Welland canal.

If such a proposition is seriously put before Congress the St. Lawrence scheme will have hard sledding.

Arches and the Palm Beach Accident

SINCE structural engineering first began, masonry arches built on good foundations have justly been regarded as almost indestructible. Their record of performance is correspondingly good. In particular, no case comes to mind of failure of an arch during construction, when the arch itself was complete but not all of the load had been applied. Against such a background of fact the Palm Beach bridge collapse stands out in striking contrast. It puts a bad blemish on arch history, and had the collapse occurred three days later, with traffic on the structure, loss of life would have made it a much worse blemish, an indictment of the whole profession. Even as the case stands it is such an indictment; the world expects better of its trusted builders than to let completed arches that are still supported by their centering collapse beneath the very feet of the builders.

Comparison of present practice with older experiences is not altogether proper, for modern arch construction is of a new kind. A hundred arches exist today and dozens of new ones are built, where one existed or was built in the period of supreme domination of the stone arch, partly for the reason that the modern arch is much cheaper than its progenitor. One of the necessary steps in this decrease of cost and multiplication of number has been close study of economy, made possible by advance in the science of mechanics; but the more highly economical design, while in many respects safer, has not the same surplus of strength that used to be provided in the massive stone barrel-vaults and ponderous abutments. Materials, types and service requirements have changed; stone, a substance of great strength, has been replaced by concrete, a material that starts out with low strength; thick arches sprung between abutment piers and stiffened by backing masonry have given way to thin rings bearing against correspondingly thin supports and carrying a superstructure that adds no strength; and the relative magnitude of the traffic loads has been multiplied. Further, modern work is more hurried: arch bridges are today built in months where formerly years were taken for construction. Comparisons with stone arch experience must take account of these changes.

In the Palm Beach accident a most interesting set of possible sources of trouble presents itself, and the case is therefore of remarkable value for professional study. Foundation and pier stability, the elastic continuity of a series of arches, too great structural flexibility, weak material, and incautious construction practices all invite attention. Fuller data than given in R. F. Ensey's report in this issue are required but certain reflections are warranted even now.

Mr. Ensey suggests that failure of Pier 9 may be primarily to blame for the collapse. The engineers also report finding defective conditions at the pier base. What sort of failure, if any, occurred here is yet to be explained. Vertical crushing of any large amount seems unlikely with the foundation on rock, but tilting might occur under the action of the arch moments. A pier which is shown by drawings as being flat-bottomed and stable may be so built as to have a rounded base, and the effect of such a condition on arch stresses is rarely computed. Middle-third calculations for pier bases are one of the commonplaces of arch design, perhaps to the degree that they get less real thinking than desirable. One fact worth remembering is that even the prettiest middle-third base pressure may not prevent an imperfectly-founded pier from rocking enough to alter the stress action of the arches. Only thoroughly competent field engineering will make a foundation rigid enough for the purpose. Both for this reason and to allow for imperfect seating of the base, it may in some cases be safer practice to analyze arches for pivoted or rocking piers.

At best a series of arch spans, to which the preceding applies, is not a simple subject for analysis. From one point of view, it is on the side of safety to design each arch as independent, but unfortunately such procedure would ignore the transmission of deformation, i.e., the increased flexibility of the structure. The engineers of the Palm Beach bridge have been led by *ex post facto* consideration of this continuity to a remarkable hypothesis concerning the failure, as follows: The spandrel filling, which contrary to their intentions was being placed complete in one spandrel space and then in the next, was a pumped "sand" that was virtually a liquid when deposited but became very stiff by draining. The east abutment space being filled first, the filling subjected the first arch to unbalanced hydrostatic loading, and this by elastic transmission distorted all the arches, humping them up to the west. When the space over the first pier was then filled, it should have balanced the load on the first arch and restored its symmetry; but, the abutment fill having by this time set, the first arch could not resume its unstrained shape, and the result was merely an increased distortion of the other six arches. This process continuing for four or five spandrel spaces, the arches were squeezed westward very sharply (the draw is said to have become jammed). Then the filling was started at the draw end, and the remaining spandrel spaces were filled from west to east. A reversed straining action thus affected the last three arches, resulting in sharp humping up at the middle of the arch last to be filled. Result, rupture of this arch upward! The hypothesis is ingenious, if rather paradoxical.

Obviously, such possibilities compel one to look with more respect upon continuous-arch theory than has been accorded it hitherto. It is timely to reflect whether we have not been carrying the process of paring down reinforced-concrete arch designs too far. It is easy to design a structure of this type that is safe when built but unsafe to build. Some such have been designed, and some have been built. Despite low bids, economy in construction is not to be secured this way, in the long run; and even apart from economy a conservative judgment, taking into account such special factors of flexibility and weakness as above suggested, would characterize a few of the recent designs of reinforced-concrete arches as too light. If we can return to the state when an arch will be to all intents indestructible after closure of the ring, we will be in sounder position.

FROM JOB AND OFFICE

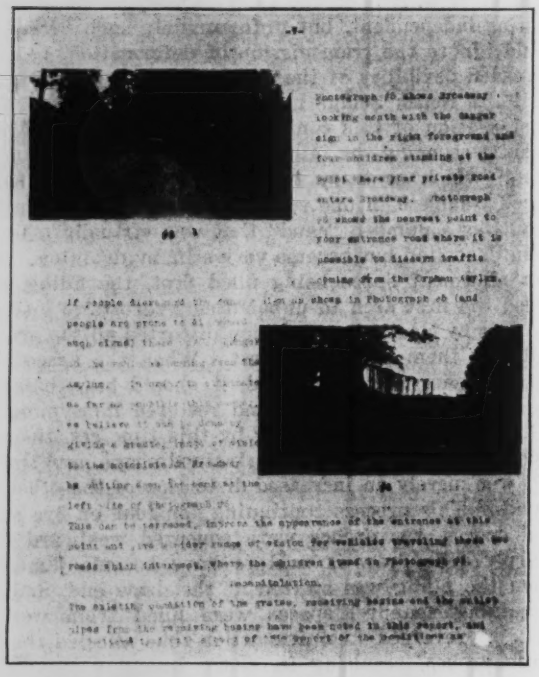
Hints That Cut Costs and Time — *For Contractor and Average Engineer*

Photographs in Engineering Reports

BY B. DUNCAN MCCLAVE
McClave & McClave, Engineers, Cliffside, N. J.

THE explanation of existing conditions very often acts as a great aid to the engineer's clients when these explanations are supplemented with photographs or cuts. The expense of having cuts made for small reports precludes their use in a great many instances. The use of photographs, however, is quite inexpensive and can be used by the engineer to show his clients pictorially a point upon which emphasis is made in the report.

The usual method of showing a photograph is by



PHOTOSTAT OF REPORT ILLUSTRATED AS DESCRIBED HEREIN

pasting it on a report. This method is not as satisfactory as the engineer desires. Accordingly we have devised a method which is very practical and we recommend it to our colleagues in the preparation of small and inexpensive engineering reports. The procedure is as follows:

1. Type the report leaving sufficient untyped space at the proper place in the report for the negative to be inserted.

2. Cut some Vandyke or blueprint paper the exact size of the paper on which the report is written (Vandyke paper will give a sepia photograph and the blueprint paper will give a blue photograph. Care should be taken as to the stock so that the paper will approximate in size as well as in quality, the paper on which the report is written).

3. Cut a piece of opaque paper slightly larger than the report paper. In this make an opening the same size as the negative and in the same location on the sheet as is desired for this photograph according to the rough draft of the report already typed and referred to in paragraph 1.

4. Print the negative with the opaque covering between the Vandyke or blueprint paper and the illuminating source.

5. Care must be taken to wash the Vandyke paper with Vandyke salt and also have the blueprint well washed so that the print may be real white with the exception, of course, of the photograph.

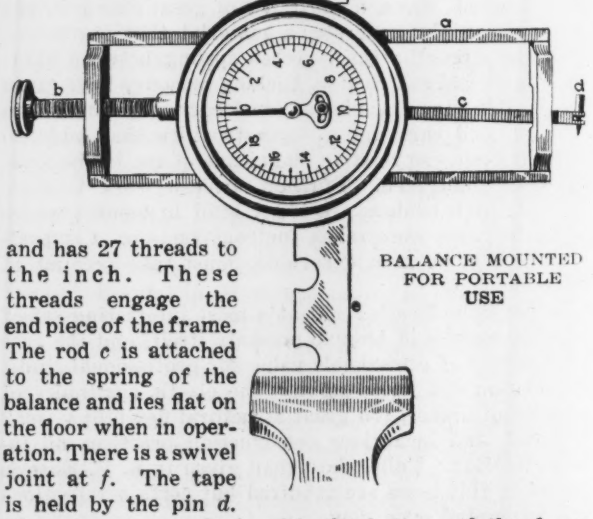
6. Retype the report upon the sheet on which the photograph has been printed.

We have found this method quite successful for small work and heartily recommend it in spite of the fact that it requires additional care and time over the methods already in practice.

A Balance for Standardizing Tapes

BY WALTER S. WEEKS
Associate Professor of Mining, University of California

THE most convenient place to standardize a tape is the concrete or brick floor of a building. It is usually inconvenient to build a permanent support for a balance so I have devised a convenient portable arrangement which can be placed on the floor and held in place by weights. The balance used is a Chatillon "No. 33, Serial H" reading to 20 lb. The frame of steel, shown in the accompanying sketch as *a*, is 12 in. long and wide enough to hold the box-like cover on the back of the balance. The screw *b* is ½ in. in diameter



BALANCE MOUNTED FOR PORTABLE USE

and has 27 threads to the inch. These threads engage the end piece of the frame. The rod *c* is attached to the spring of the balance and lies flat on the floor when in operation. There is a swivel joint at *f*. The tape is held by the pin *d*. The wings *e* are flush with the bottom of the frame and lie flat on the floor.

The surveyor should have a high-grade tape standardized while supported. This is done by the Bureau

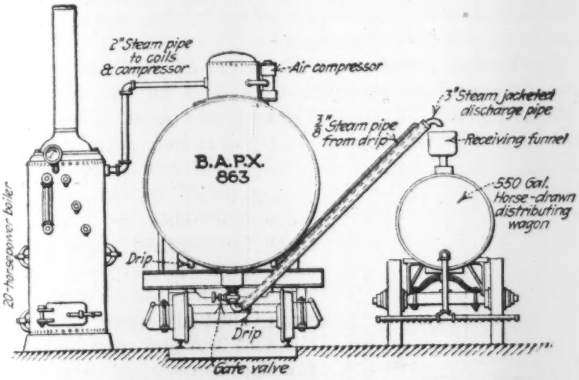
of Standards. Tapes may be obtained with the temperature corrections etched at one end.

This standard tape is stretched out and the standard pull applied with the balance and an exact 100 ft. is marked off. The working tape is then stretched between the points with the end that is away from the balance held on one of the points.

Steam-Jacketed Pipe Facilitates Unloading of Tank Cars

By A. D. Blakeslee
C. W. Blakeslee and Sons, Contractors, New Haven, Conn.

For the past several years we have been building bituminous macadam pavements by the penetration method applying the bitumen under pressure from tank wagons drawn by a steam roller. This material comes to us in tank cars and we have a boiler alongside the siding and heat the material enough so that we can handle it and load it into our tank wagons. We then haul it to the job and heat it to the required temperature.



SPECIAL ARRANGEMENT FOR TANK CAR UNLOADING

In transferring the material from car to tank wagon we first used a hand pump in the top of the car and then let it run by gravity from this pump into the wagons. Later we tried using the air compressors with which the tank cars were equipped. This air would force the bitumen out of the bottom of the car up through a pipe into the wagons. We could load two wagons very satisfactorily this way, but when they returned for the next trip, after being away for about two hours we found that the material in the pipe all cooled off so that it was impossible to use the air pump, therefore we replaced our stand pipe with a steam-jacketed pipe.

We now take the steam from the drips of the coils in the car and turn this into the steam jacket. We have found this to work very satisfactorily and are using this method right along. It saves two laborers at the car and about one day's time in unloading, for now we are able to get started sooner than when we pumped by hand. In addition to this, it saves us a great deal of annoyance for the hand pump was continually getting broken and out of order.

Cars are generally placed on our siding about 2 p.m. and if we get them connected and steam on by 4 o'clock the same afternoon we are generally able to start unloading the following morning about 10 o'clock. It then takes us the rest of that day and two more days to unload a car of about 7,500 gal. and apply the bitumen on the street.

Air Lift Removes Sand Plugs From Deep Wells

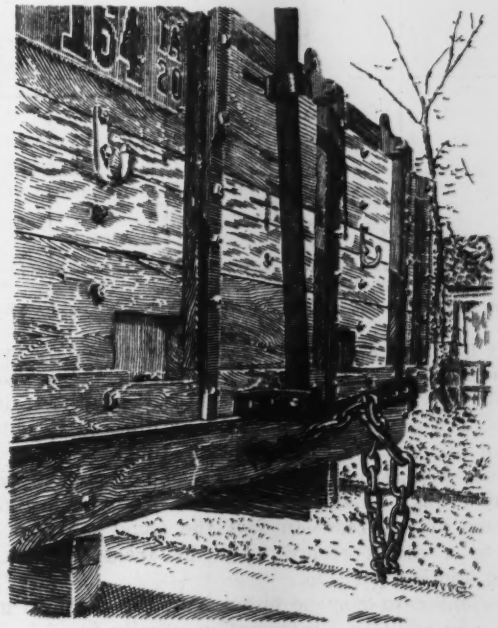
By Dennison Fairchild
Supervisor Bridges and Buildings, Northern Pacific Ry., Duluth, Minn.

Air lifts have been successful in two cases observed in removing sand plugs in deep wells. One well, with an 8-in. casing 145 ft. deep (from which about 100,000 gal. of water was pumped daily), became clogged with sand to such an extent that it practically stopped the supply. A test developed 14 ft. of sand and small gravel. A ¾-in. pipe to the sand was inserted and air forced to the bottom, the rising bubbles keeping the water disturbed and the sand in suspension, and it was thrown out very quickly and at little expense. In another case, the well was 236 ft. deep with an 8-in. casing, and the sand was beginning to shut off the supply and get into the pump. There was available only 150 ft. of ½-in. pipe which was connected up with a compressor. The rising air created enough suction to lift the sand and the water was clear and running free of sand at the end of 25 minutes.

Device for Spreading Gravel Evenly

By Allen P. Child
Kansas City, Mo.

A bent lever attached to the hinged door of a dump-body truck is used by the Iowa Highway Commission for spreading gravel evenly on roads. The lever has the lower end, at a point 2 or 3 in. from the fulcrum, bent at right angles with the main portion. The fulcrum



BENT LEVER ON TRUCK DOOR CONTROLS OPENING

is attached near the bottom edge of the door and on the center line. The short arm of the lever has several holes bored in it and a chain attached to the floor sill of the body bottom is carried out and fastened in one of the holes. When the lever is hooked at the top, the door is held tightly closed. As the lever is lowered, the door opens to any desired amount determined by the

length of chain. Dry gravel sifts through as evenly and smoothly as desired. Wet gravel requires jiggling of the lever and a larger opening. Although the device costs little to attach, it is necessary to have a man to operate it.

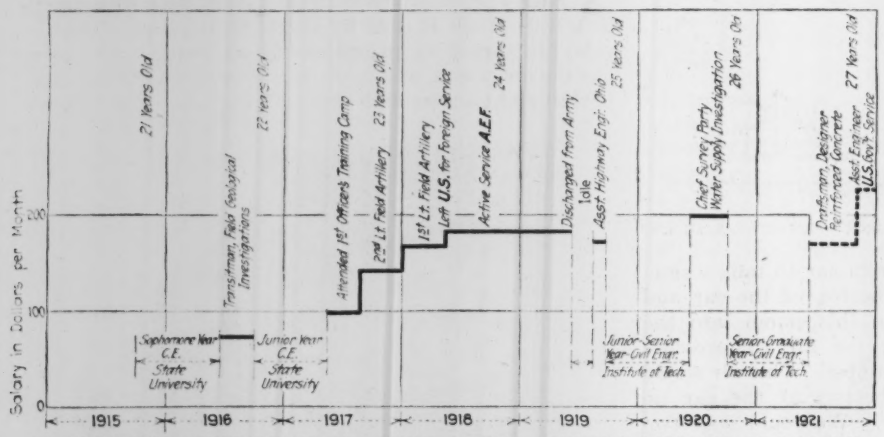
Charted Personal Record Used as Aid in Application for Employment

By K. B. Skardon

Assistant Engineer, U. S. Railroad Administration, Chicago

LETTERS of application for employment will always play an important part in bringing engineers to jobs and jobs to engineers. In many cases final decisions must be made with no other information available than that submitted in a letter written by the applicant. This is especially true if it is desirable to fill the vacancy without the delay and expense necessitated by conferences.

The writer has had occasion recently to apply for engineering positions by letter. He has found it difficult to condense the necessary facts and to present them in a convincing manner, in short, to write a letter of application which speaks for him in his absence. Some thought on the subject led to an experiment in arranging pertinent facts graphically. Reference to the accompanying chart will show the results.



PROFESSIONAL RECORD CHART GIVES VARIED INFORMATION OF APPLICANT

It is felt that a better idea of the applicant's experience and training is obtained when the facts are placed on a chart. The chart gives a continuity to the various events of a career which would be difficult to obtain without its use. The element of time used for the abscissas brings out duration of employment in various capacities. Salaries used as the ordinates are good measures of progress—in fact the usual measure applied to a man's record when he faces the job of finding another position.

Sufficient data may be entered on the chart to give it life, and additional information usually furnished in a letter of application may be enclosed in definite form for each period on the chart. The letter proper may then be confined to an introduction and consideration of acceptable salary, time possible to report for work or conference and other pertinent data not recorded on the enclosures.

The chart, with supporting data should also serve as a valuable record for an engineer who is interested in following his own progress and achievement with the idea in mind of analyzing it and profiting by the analysis. He can give definite direction to his efforts and improve his experience at the points where weakness is indicated. The chart may also serve for reference as a personnel record in organizations employing technically trained men of various capacities.

FROM JOB AND OFFICE

Hints That Cut Costs and Time

An Improved Stadia Rod

By E. B. Debler

INASMUCH as approximate accuracy only is wanted on stadia surveys of any great extent, homemade rods both for vertical-angle reading and for spotting distances, often surpass in legibility and ease of reading level rods of standard make. In the following paragraphs such a rod, developed on work with which I have been connected, is described.

The board should be 2½ in. wide, of sufficient thickness for requisite strength dependent on the material used and given one coat of dead black paint. The numbers are 3-in. aluminum house numbers available in novelty and hardware stores.

Sketch "A" on the opposite page represents the arrangement for vertical angle work and sketch "B" for level work. Where both types of work are simultaneously done the two sides of the rod may be used for the two scales. The "A" scale is based on the use of the top interval only, the accuracy therewith being in keeping with other factors in stadia work generally.

The "0" of both scales is at a distance above the bottom of the rod corresponding to the average set up for the instrument in use, usually about 4.8 ft. for a transit and 4.5 ft. for a plane table.

The graduation for scale "A" may be one-half foot for each number or in case of instruments incapable of easy adjustment may be made to fit the instrument by observing the intercept on the rod for a measured distance. The range may be increased by the addition of a mark below the zero corresponding to 500 ft. of distance.

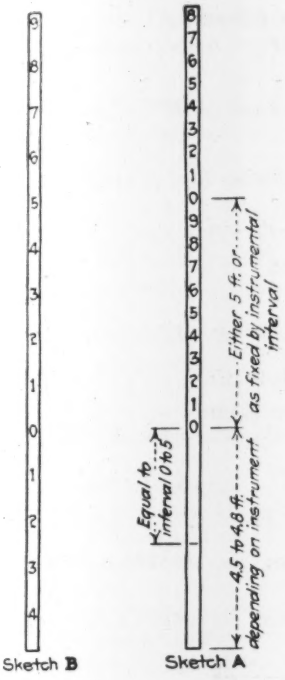
For scale "B" the numbers are a foot apart. Additional subdivisions of the rod may be accomplished by the use of brassheaded tacks though this is usually not necessary for the average instrumentman as the tops and bottoms of the figures for the angle scale represent 25 ft. under or above the hundred, with but 50 ft. between the edges of the numbers.

The cost of the rod is but a fraction of the cost of any well-painted rod and its legibility for shots of any distance is far superior to that of any painted rod.

In operation the middle hair is trained on the zero and the full distance read direct. For vertical angle

FROM JOB AND OFFICE

For Contractor and Average Engineer


Sketch B
Sketch A
Equal to interval 0.65
4.5 to 4.8 ft.
depending on instrument
Either 5 ft. or as fixed by instrumental interval

work the instrument is also thereby properly set. All HI calculations are eliminated, only ground elevations being recorded.

Errors due to instrumental height not corresponding with the "0" of the rod are small and compensating and may be disregarded.

The especial advantages of this rod are the elimination of mental processes necessary for the determination of distance required with most rods and the superior legibility of the rod due to contrast of reflection of light from the bright metal and black surfaces, the former making for speed and accuracy and the latter increasing the range of visibility.

Patrol System for Ditch Maintenance

As a remedy for the almost universal condition of neglect of drainage ditches, due partly to inadequate legislation for maintenance, the introduction of the patrol system as used on highways was suggested at the recent meeting of the National Drainage Congress by S. H. McCrory, chief of the division of agricultural engineering, U. S. Department of Agriculture. In his opinion it would be advisable to provide for a superintendent of ditches, particularly in counties having a large amount of drainage. He should be a full-time employee with experience in drainage work and should have authority and funds for patroling the ditches and keeping them in good order. The authority must be centralized in the hands of one man who would be the executive officer of the district and be responsible for the proper maintenance of all drains within that district. This would not only secure better drainage but the farmers would more nearly realize the benefits that they have been led to expect from improved drainage. If this is to be accomplished, however, the provision in drainage laws in regard to maintenance must be made mandatory and not optional.

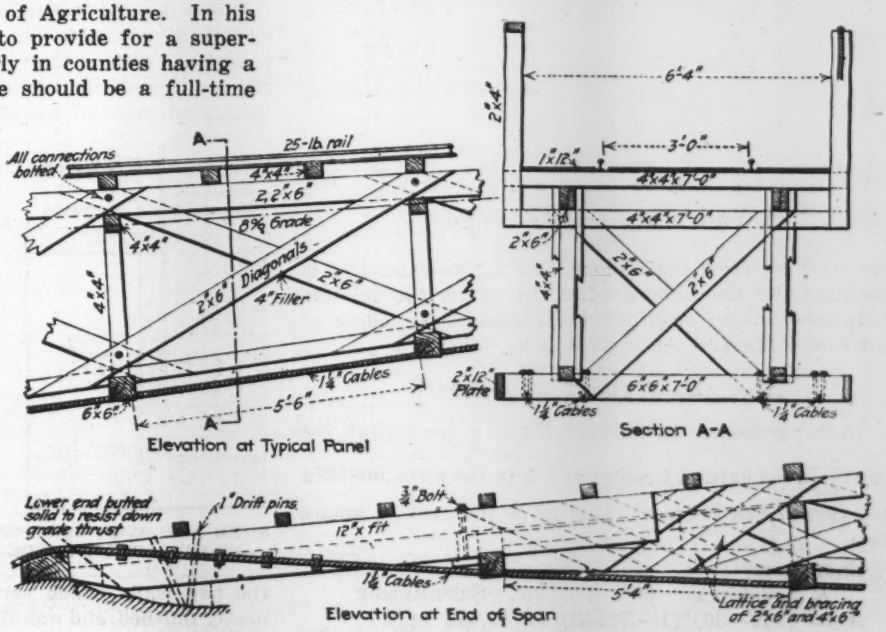
Temporary Bridge Has Rigid Deck Truss and Cables for Bottom Chords

To effect a temporary crossing of the Kern River, California, for delivering construction materials, engineers of the San Joaquin Light & Power Corp. designed a bridge with a 110-ft. span consisting of a rigid deck truss built of timber and whose bottom chords were composed of four 1¼-in. cables. This design afforded the desired capacity of 6 tons, the comparatively high degree of stability required for the operation of narrow-gage cars and made it possible to build the bridge quickly at low cost. Moreover, this design did not require falsework which would have been difficult at this site.

The cables were first anchored firmly in place, great

SUSPENSION BRIDGE WITH RIGID DECK TRUSS

care being taken to make sure that all four of them had equal sag. Transverse members of the truss, i.e., those that were to have bearing on all four cables, were then put in place, these pieces having previously been notched to insure even spacing of the cables. A working floor was then made by laying loose boards on these cross-pieces and the truss was erected in place. As at first assembled the structure was held in position



DETAILS OF TIMBER TRUSS OF SUSPENSION BRIDGE

lightly, care being exercised to obtain a uniform distribution of the load. The structure was then tied firmly together, the workmen being evenly distributed during this operation to obviate any distortion to the bridge.

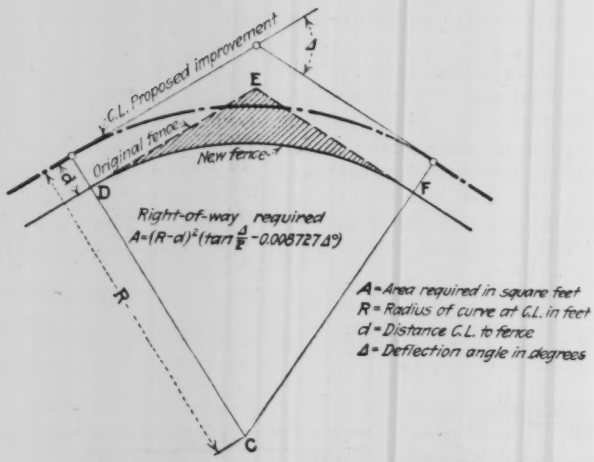
The timber members were proportioned to carry the live-load only, while the cables carried both dead and live-loads. By making the joints secure and fastening the cables rigidly at the panel points, the structure was expected to act as an inverted bow-string truss. Had the joints been left loose, or if the diagonals were not strong enough to carry the loads the action of the structure, it was pointed out, would have been between that of a bow-string truss and a stiffened suspension bridge.

The cost of the structure, including an adjacent 45-ft. span, and general overhead charges, was in the neighborhood of $2,000.

How to Get Circular Right-of-Way Areas

By M. E. Webster
District Office Engineer, Division of Highways, Illinois

IN THE design of every section of road there is present the problem of securing right-of-way. This problem resolves itself into two parts: The buying of a strip between fence lines, and the securing of additional area at curves. In order to facilitate the computing of the area of right-of-way required in the latter case the formula given herewith was derived. Assuming that



GRAPHIC APPLICATION OF FORMULA

the distance from the tangent line to the fence line is substantially the same around the curve, the relation between the area required, the radius of the curve at the center line and the angle Δ is as follows:

$$A = (R—d)^2(\tan \frac{\Delta}{2} — .00872\Delta^\circ)$$

In this equation the units of R and d are in feet, the $\tan \frac{\Delta}{2}$ is the natural tangent and Δ in the term $.008727\Delta$ is expressed in degrees. This gives the area in square feet.

Example:—

$R = 300'$; $\Delta = 90°$; $d = 30'$. Substituting

$A = (300—30)^2(1—.78543) = 15{,}642$ sq.ft.

FROM JOB AND OFFICE

Hints That Cut Costs and Time

The formula is developed as follows:

Area required = Area $CDEF$ — Area circular sector CDF (1)

Area $CDEF = DE \times DC$ or, since $DC = (R—d)$, $DE \times (R—d)$

But from circular curve formulas $T = R \tan \frac{\Delta}{2}$

$$\therefore DE = (R—d) \tan \frac{\Delta}{2}$$

$$\text{Area } CDEF — (R—d)^2 \tan \frac{\Delta}{2} \quad (2)$$

$$\text{Circular Area } CDF = \frac{\Delta}{360} \times \pi (R—d)^2$$

$$\log \pi = 0.49715$$

$$\log 360 = 2.55630$$

$$7.94085 = \log .008727 \quad (3)$$

$$\text{Circular Area } CDF = .008727 \times \Delta \times (R—d)^2$$

Combining (2) and (3) in (1)

$$\text{Area required} = (R—d)^2 \tan \frac{\Delta}{2} — .008727 \Delta (R—d)^2$$

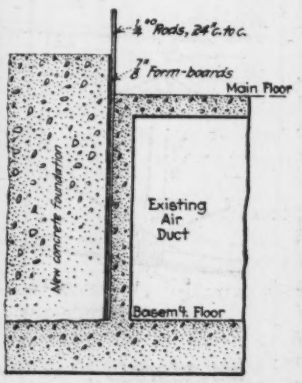
$$= (R—d)^2 (\tan \frac{\Delta}{2} — .008727 \Delta) \quad (4)$$

Removing Forms From 1-in. Space

By R. C. Reese
Architectural Engineer, Pittsfield, Mass.

A SUCCESSFUL method of removing forms from a very narrow space is illustrated by the accompanying sketch, as it was employed in remodeling a steam electric plant.

It was desired to construct a concrete turbine foundation about 9 ft. wide and 10 ft. high in the power house basement, with a clear space of about 1 in. between the new foundation and an existing air duct to prevent the transference of vibration from one to the other.



FORM FOR EASY REMOVAL FROM NARROW SPACE

A series of ¾-in. plain, round reinforcing rods was placed vertically between the existing wall and the ⅞-in. horizontal form boards, with the ends of the rods projecting about 2 ft. above the wall. After the concrete had set the rods were pulled out by the traveling bridge crane in the building, with surprisingly little difficulty; in fact a lever pulling rig could have been used. When the form boards were driven out horizontally there resulted a clear space of just about 1 in. between the two walls which serves its purpose admirably, is neatly finished, and was obtained with but little difficulty.

FROM JOB AND OFFICE

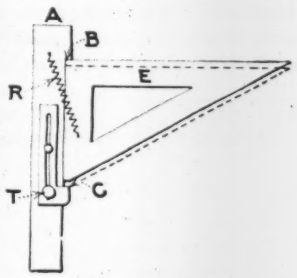
For Contractor and Average Engineer

Device for Cross Hatching

BY P. LÉNIZ
Engineer and Contractor, Santiago, Cuba

A HATCHING device which I have used in my office for many years with very good results is described in the following paragraphs.

It is composed of a triangle *E* and a guide *A* as shown in the sketch reproduced herewith. This guide has two projecting parts or stops; *B*, which is fixed, and *C*, which is movable and is tightened by means of the screw *T*. The triangle and the guide are united by the spring *R* in a manner such that the triangle is always touching the stop *B*.



CROSS-HATCHING ARRANGEMENT

To use the device proceed as follows: Draw the first line with the instrument in the position as shown in the figure. Hold the guide *A* and at the same time move the triangle *E* downward until it touches *C* as indicated by the dotted lines. The triangle is held firm. Loosen the guide *A* and the spring *R* pulls the guide *A* until *B* engages the triangle. The instrument is then ready to trace the second line, etc. The stop *C* is movable in order to vary the spacing between the lines of the hatching and is fixed by means of the screw *T*.

Cost Sheet for Engineers in General Practice Is Complete in Detail

BY EDWIN P. ARNESON
Walton & Arneson, San Antonio, Tex.

A COST sheet which has been found satisfactory for recording labor costs and miscellaneous expenditures on field work by a firm engaged in general engineering practice is illustrated by the drawing. The sheet is a "blue-line" print, 11 x 16 in., punched on the left margin for fitting, when folded, a standard "I-P" binder 8½ x 11 in.

The chief of party carries this sheet in his computation book. On the upper part of the blank he keeps the time of his party. On the lower part he lists his expense account. The sums of both classes of expenditure are united into a total cost of the job for the month. At the end of the month the sheet is turned into the headquarters office where time checks are prepared and the chief of party is reimbursed for his expenses on the firm's account. The cost sheet is then filed in a standard letter file.

CLIENT | JOB | Month | 192

LABOR

Employee Name and Classification | Time Unit | Rate $ | Days of Month 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 | Totals for Month: Total Units, Total Cost, $ | Remarks (Use reverse side of sheet if necessary)

Remarks applicable to particular Date | Signature | Timekeeper | Labor Total

MATERIALS AND MISCELLANEOUS

Date | Details of Cost | Cost | Date | Details of Cost Brought forward | Cost | Details of Cost Brought forward | Cost | MTRL. & MISCL. TOTAL | TOTAL COST

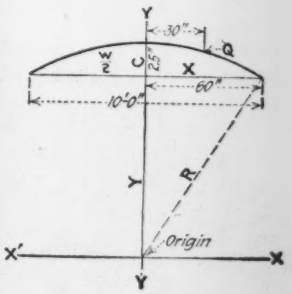
Carry forward | Carry forward | Total Cost (Carry forward)

FIELD ENGINEERING COST SHEET

Determining Tangential Offsets for Road Crowns

BY E. M. CRAWFORD
Effingham, Illinois

IN CONSTRUCTING roads and streets it is sometimes desirable to have a crown that is an arc of a circle instead of a parabolic section. A useful method of figuring the tangent offset for a circular section is given below. It can be used to make corrections on grade stakes for earth-road work, or to find the offsets when making paving templets. In this class of work the degree of curvature is so small that ordinary tables cannot be used.



In determining the offset for any given point on the tangent, you have given the width of the surfacing *W* and the height of crown *C* (see accompanying figure). Here, $W = 10$ ft. and C, 2.5 in. (the slope being assumed ½ in. in 1 ft.).

Then $X^2 + Y^2 = R^2$

But $R = Y + 2.5$, and $X = 60$ in.

$\therefore 3{,}600 + Y^2 = (Y + 2.5)^2$

$= Y^2 + 5Y + 6.25$

$Y = 718.75$

$R = 718.75 + 2.5 = 721.25$ ft.

To find the tangent offset at any point on the tangent such as *Q*, find the value of *Y* on the curve at that point. Subtract the value of *Y* from the radius and the result will be the required offset.

Example:

At *Q*, $X = 30$ in.

$X^2 + Y^2 = R^2$

$900 + Y^2 = (721.25)^2$

$Y^2 = 519{,}301.5625$

$Y = 720.62$

and $q = 721.25 - 720.63$

$= 0.64$ in.

Erection of Hurricane Gulch Arch Bridge in Alaska

Cantilever Erection of Most Northerly Railway Structure in America—Hydraulic-Jack Adjustment of Backstays Instead of Wedge and Screw Toggle—How Arch Members Were Transferred Across Gulch

By E. G. Amesbury
Assistant Engineer, Erecting Department, American Bridge Co., Pittsburgh, Pa.

ERECTION of the 384-ft. steel arch of the Alaskan R.R. over Hurricane Gulch, about half way between Seward and Fairbanks, was completed in August, 1921. The methods by which the erection was carried out included several decided novelties, which the results proved well adapted to the needs of the case.

This arch is the second steel bridge erected on the government railway in Alaska, whose main line between Seward and Fairbanks, 467.6 miles, will soon be completed. It is located 284 miles north of the terminus at Seward, and to the writer's knowledge is the farthest north and west of any steel railway bridge on the American continent. However, a steel viaduct will shortly be erected on the same line 63 miles farther north.

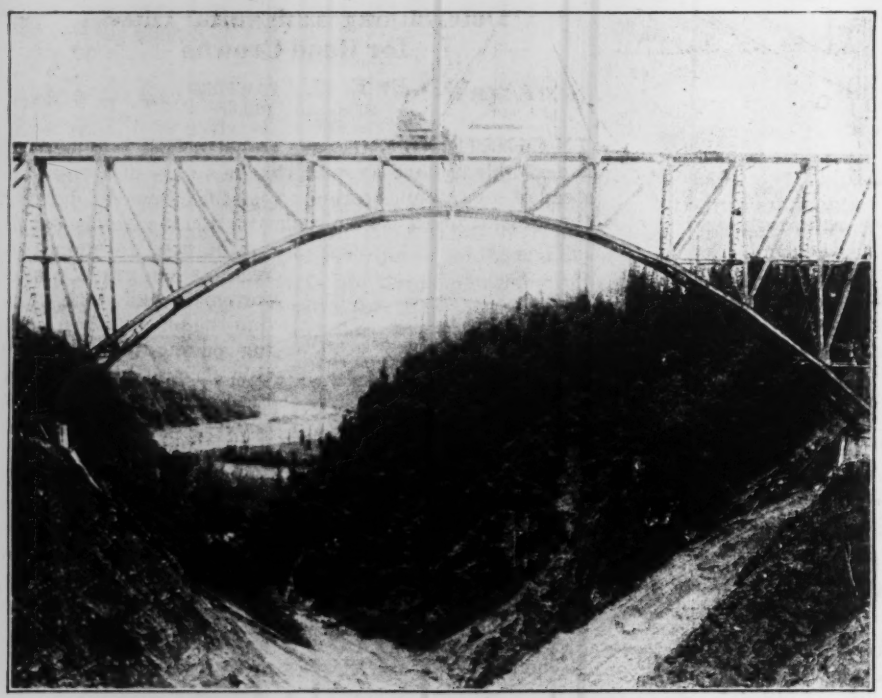


FIG. 1. SETTING THE CLOSING MEMBER, HURRICANE GULCH ARCH, ALASKAN R. R.

Field Conditions—The Hurricane Gulch structure is a single-track deck bridge 914 ft. long located on tangent. The arch span, 384 ft. long, is flanked on either end by a 120-ft. riveted-truss deck span, beyond which there is at the south end a 50-ft. plate-girder span and at the north end a steel viaduct 240 ft. long. The arch is 125 ft. 3 in. deep at the ends and 25 ft. 3 in. at the center. Its top chords are spaced 14 ft. apart; the trusses are battered 1:6. Base of rail is about 296 ft. above the bottom of the gulch. The heaviest member is the end section of the bottom chord, weighing 12½ tons. The total tonnage in the arch is 911 tons; the rest of the structure contains 535 tons of steel.

Track had been laid to the southern end of the structure before erection of steel started. A yard was established alongside of the railroad a few hundred feet south of the bridge, through which all material, for both south and north ends, was handled with a locomotive erecting crane, and where it was assembled and riveted as far as possible.

It was planned to erect the arch by the cantilever method, each half to be built out from the shore and held back by steel backstays. Cantilever erection made a double-ended erecting operation, which introduced the problem of getting material across the gulch for the north half of the arch and approach spans. It was impracticable to transfer material around or down through the gulch and it could not be brought in from the north; therefore the only two ways open for feeding material to the organization on the north half of the structure were (1) cableway transfer, and (2) lowering into the gulch with an erecting unit standing on the end of the south half of the arch and outhauling the members with another unit on the north half. Both were used, but, contrary to the original intentions, all the arch steel was transferred by the second method.

To facilitate erection, the center of gravity of each bottom-chord member was figured in the drawing-room, so that hitches could be applied at such points on the chords that they would hang in their relative permanent position while being placed.

Backstays—A locomotive erecting crane began the erection work by setting the 50-ft. plate girder span at the south end, and then placed falsework for the 120-ft. span and erected this span. Thereafter the steel backstays for the half arches could be constructed. Steel anchorages embedded in concrete had been placed some weeks before. (Fig. 3.)

The vertical anchorage load on the south side consisted of a heavy concrete pier, which is now used by the railroad as a permanent pier for supporting the shore end of the 50-ft. girder span. The anchorage load on the north end consisted of a heavy block of concrete upon which two viaduct pedestals were built and 268 tons of railroad rails piled for additional weight.

The Alaskan Engineering Commission (Col. Frederick Mears, chairman and chief engineer) had built

a 4-ton cableway across the gulch near the site for the transportation of supplies and freight. This cableway was used to transfer the steel, erecting equipment and falsework material across the gulch for the north 120-ft. approach span and viaduct towers.

The backstay bars connecting the anchorages to the 120-ft. approach spans (which in turn connected to the ends of the top chord of the arch) were telescopic in action, as may be seen from Fig. 3. There were two pairs of backstay bars to each anchorage, or a pair to each truss, and in the telescopic joint of each pair was provision for inserting a 500-ton hydraulic jack, to be operated by a steam-driven hydraulic pump when the halves of the arch span were lowered to their permanent position. During erection these bar systems were shortened about 8½ in., which caused the ends

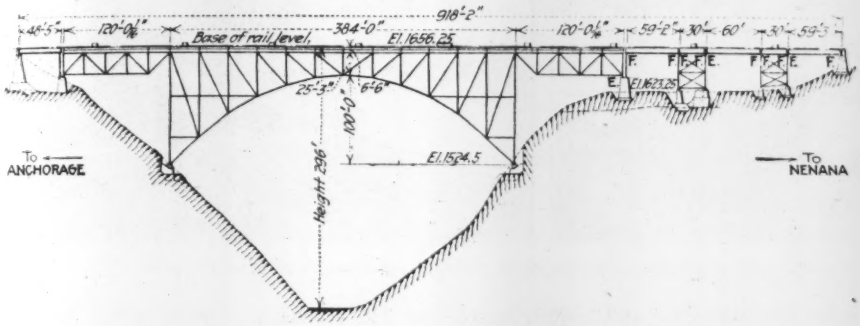


FIG. 2. OUTLINE OF HURRICANE GULCH ARCH

of each half of the arch at the center to be slightly elevated. They were held in this position by steel shims in the telescopic joint of the backstay bars until final closure. The pair of 500-ton hydraulic jacks for each anchorage was connected by a copper tubing system to the hydraulic pump, and when pressure was applied the jacks loosened the steel shims in the telescopic joint of the backstay bars, which allowed the shims to be easily withdrawn and the two halves of the arch lowered in a few minutes to a bearing on a pin in each bottom chord at the center, forming temporarily a three-hinged arch. So far as the writer can ascertain, this is the first time telescopic backstays with hydraulic jacks for adjustment have been used for closing an arch.

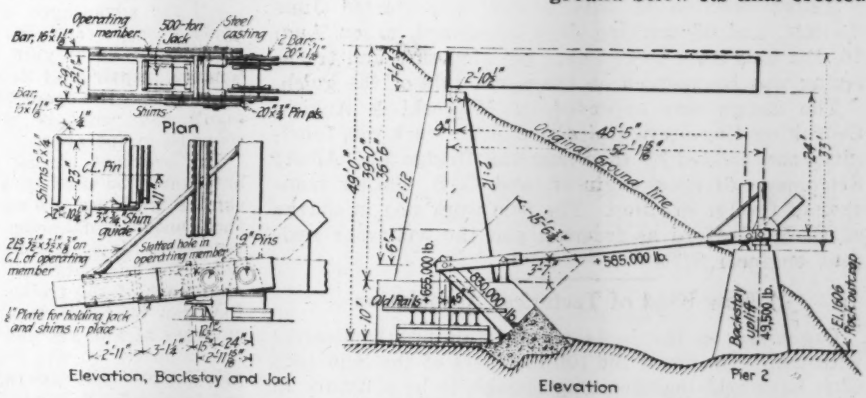


FIG. 3. SOUTH ANCHORAGE AND ERECTION BACKSTAY WITH HYDRAULIC-JACK RELEASE

The shoes of the arch were set at their proper distance apart by means of direct measurement with a 500-ft. steel tape corrected for temperature. The tape was standardized and marked by the maker to measure the distance of 384 ft., the length of the arch, while supported only at the zero and 384-ft. marks, under a tension of 50 lb. The fact that the arch closed and fitted very satisfactorily showed that there was no appreciable error in the measurement.

North Side Erection—The north half of the arch could not be erected until the north 120-ft. approach span was in place. As soon, therefore, as the south 120-ft. approach span had been erected, the falsework under it was removed and transferred in sections across the gulch by cableway. The bottom sections being slightly altered to fit the new location, it was re-erected to support the north span. The highest bent under this span was 95 ft. 6 in. high. After two panels of the north 120-ft. span had been erected with a stiffleg derrick sitting on the ground, a hoisting engine and a light A-frame steel derrick were placed on the top chords to erect the rest of the truss and arch span. The A-frame derrick was moved out panel by panel as the work proceeded, but the engine remained in one place.

Transferring Arch Material—As some of the members of the arch were too heavy to transport over the cableway, it was planned to lower them to the bottom of the gulch by a locomotive erecting crane standing on the outer end of the south half of the arch (Fig. 4) and pick them up by the derrick on the north side. This was first done with the heavy members of the end panel.

In carrying out this transfer the load falls of the A-frame derrick on the north end were lowered to the bottom of the gulch and hitched to the member. Then both sets of falls were taken up simultaneously, at such rate that the member was brought up along the slope of the gulch and landed on the ground below its final erected position. The locomotive-crane falls were then released and the member lifted up to its place in the arch by the A-frame steel derrick. On account of the great depth of the gulch, the members could be transported over the maximum gap of 192 ft. between erecting units without causing more strain on the boom in each unit than when the total load was supported independently and vertically underneath by either boom. It was found that the method worked very well, and in consequence all material for the north half of the arch was transported across the gulch in this manner rather than take the light members over the cableway.

The stringers for the arch span and deck spans were designed to set on top of the floorbeams. This allowed them to be riveted up in pairs in the yard, permanent ties placed thereon and each panel of stringers and ties erected as a unit with locomotive erecting crane.

Closing the Arch—When the two halves were com-

pleted, they were lowered to junction by the jacks in the backstays. The top chords, as intended by the designers, did not take a bearing. Therefore the structure was made into a two-hinged arch for live load by field-drilling and riveting splice plates to the top chords. The arch was designed to be closed and riveted into a two-hinged arch at a temperature of 50 deg. F.; the temperature when the closure actually took place was very near this figure.

The final erecting operation was the placing of the 30-ft. and 60-ft. viaduct girders for the north approach. These were transported across the arch and erected by locomotive erecting crane, the viaduct tower material having previously been taken over the cableway and erected with a derrick.

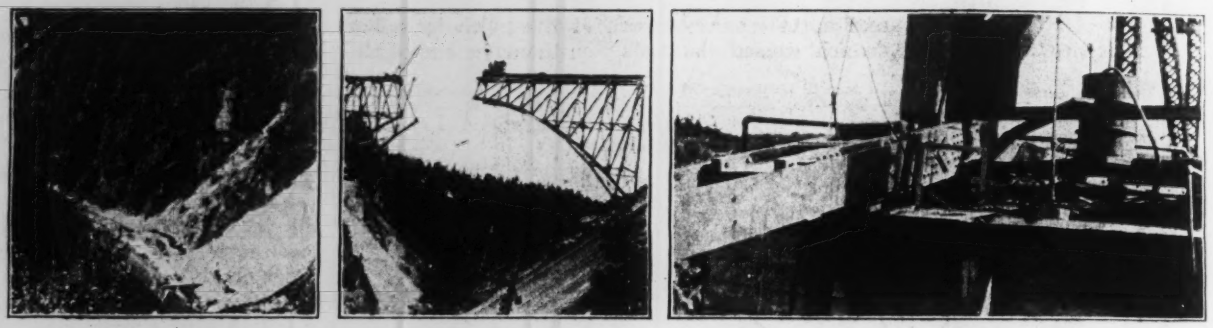


FIG. 4. TRANSFERRING ARCH STEEL ACROSS THE GULCH—BACKSTAY WITH JACK

Actual erection of this bridge was started June 8, 1921, and 60 working days afterward, or on Aug. 16, the first train passed over the structure and track-laying was commenced on the north side of the gulch.

The design was approved by Modjeski & Angier, Consulting Engineers, Chicago, and the work was fabricated and erected by the American Bridge Co., Albert Reichmann division engineer, and C. S. Garner manager of foreign erection. The field work was in charge of H. M. Braford as foreman and the writer as resident engineer.

A New Kind of Technical Association

Organized on the basis of entertaining themeselves with their own talent the 100 members of the Scientech Club have held together long enough to be a fixture in Indianapolis. It has an attendance of about thirty each Monday noon at luncheon. As in the Rotary Club those who do not attend once in four consecutive meetings are automatically dropped from membership and membership includes engineers, architects and chemists, all technical men regardless of classification. A strict time schedule is adhered to. They meet at 12:15, aliow 15 min. for assembling and 15 min. for introductions in which various stunts are employed as introducing by first name and by business getting as much fun out of it as possible. The remaining 45 min. are devoted to discussions usually of an economic nature bearing on the relation of the profession to public welfare. No one not a member may address the club without the consent of the directors. Once a month a shop talk is given by one of the members who usually discusses the business or some interior problem of his own organization. A mimeographed weekly news letter contains reports of the previous meetings and running comment on current technical events.

Electrification of Railways at Large Industrial Plants

THAT electrification of the industrial railway systems at large manufacturing plants offers possibilities of reducing the operating expenses of such systems in handling raw material, finished products and waste products was the opinion expressed by D. M. Petty, superintendent of the electrical department of the Bethlehem Steel Co., in a paper presented before the Philadelphia section of the Association of Iron and Steel Electrical Engineers. This paper, of which a brief abstract is given below, is along the lines of a paper on electric traction for railways at steel mills, noted in *Engineering News-Record*, Oct. 20, 1921, p. 652.

All the advantages of electrification on main lines will apply even more to industrial lines because of the intermittent service of yard and switching locomotives. Maintenance, repair and depreciation are less for an electric locomotive. The operating labor will be less and the engineman's pay could be somewhat less, since less skill is required in operation.

The overhead trolley system is the lowest in first cost, but cannot be used in a yard where locomotive cranes or similar machines are operated. For yard work, a sliding shoe about 3 ft. long mounted on a pantagraph or a reversible hinge is preferable to a trolley wheel, as it provides for turnouts and avoids the necessity of accurate alignment of the trolley wire. But the amount of current that can be taken from a wire is limited to about 1,000 amperes at 5 m.p.h. and becomes slightly less as the speed is increased. In the third-rail system, the bottom contact plan is the more satisfactory, as it is easier to protect and can easily be stepped over by men working in the yard. There are difficulties in applying this system to congested yards, but these difficulties may be overcome by a careful layout of switches and crossovers.

Contact systems, with energized boxes in the track engaging a long shoe on the engine, are at a disadvantage in yards, but a few miles of line are operated by such systems. Storage battery locomotives, larger than those used so extensively in mines, offer many advantages. Batteries with cells of sufficiently large capacity have been wanting, but manufacturers are working along this line and high-capacity cells of both alkaline and acid batteries will soon be available. Batteries may be charged while on the engine, or duplicate removable sets may be provided to keep the engine in continual service. Disadvantages are principally in the first cost of the battery and its short life. Thus a lead battery for a 60-ton locomotive would cost about $25,000; its renewal would cost $21,000, and its life would be from three to five years. Such a battery is not yet available.

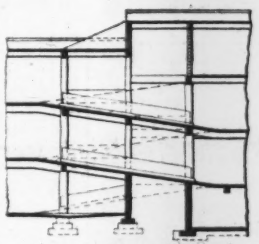
A combination storage battery and current collecting locomotive, such as has been used in mining work, may be adapted to industrial plants where the track layout precludes the general use of current distribution, but where the

use of an ordinary storage battery locomotive would involve excessive weight and power.

Conclusions—(1) The time is ripe for the electrification of industrial plant railways; (2) the storage battery should be avoided if local conditions permit; (3) the under-running third rail is the best collector system for heavy work and low voltages; (4) a combination locomotive should be used where yard congestion prohibits the use of a third rail; (5) where long hauls must be made, a voltage higher than 250 volts must be used, but the locomotives must be arranged to operate also at 250 volts in the yard and, if the conditions demand it, to operate on a storage battery.

New Ramp System for Garages

A NEW type of garage which is the first building incorporating the d'Humy Motoramp system has just been completed at Poughkeepsie, New York. The d'Humy system is based upon the construction of a building in practically two sections, the floors of one-half the building being halfway between the floors in the other half. By this modification ramps half the usual length may be used to connect the various floors a half story apart. These short ramps may be so arranged that they permit continuous travel up or down through the building. The new garage at Poughkeepsie has been constructed for the Nelson House Co., Inc., and is a three-story structure approximately 100 ft. square.



Section A-A
Showing full building height

Because of the fact that the ramps are half lengths, they are short enough to be employed as connecting passages between the main car storage aisles. As a consequence, in the average building a d'Humy Motoramp system will not only take up less space than an ordinary ramp, but it will permit the storage of two cars more per floor than if a single elevator were used. In the Nelson House garage, the ramps are about 7 ft. wider than is necessary and consequently the building does not give as high storage capacity as it otherwise would.

One of the advantages which is claimed for the d'Humy system is that the sides of the ramps may be left open, it being unnecessary to box them in as is the usual practice. The open construction affords the operator of a motor car a long view ahead, whether rising or descending.

The architect on the Nelson House garage was Edward T. Smith, of Poughkeepsie, and its builder, Edgar V. Anderson of that city. Information contained in this article was submitted by the Ramp Building Corporation, 115 Broad St., New York City, owner of the d'Humy Motoramp patents, from whom license rights may be obtained.

FIG. 1. RAMPS OF SHORT LENGTH IN NELSON HOUSE GARAGE

Co-operative Studies of Ozone for Air Purification

A CO-OPERATIVE study of the use of ozone to deodorize and purify the air of buildings by oxidation of organic matter and the possible killing of bacteria has been begun at the Pittsburgh Experiment Station of the United States Bureau of Mines in co-operation with the Research Bureau of the American Society of Heating and Ventilating Engineers, which is housed in the same building as the Experiment Station. Attention is being given to an accurate determination of the percentage of ozone and oxides of nitrogen produced by different types of ozone machines and to methods for determining the very small quantities of ozone and oxides of nitrogen that may be present in the air treated by these machines. Later on the United States Public Health Service will co-operate in the studies of the health and sanitation phases of the subject. The work is being done under the direction of A. C. Fieldner, supervising chemist and superintendent of the Pittsburgh Station of the Bureau of Mines, and Dr. R. R. Sayers, chief surgeon, Bureau of Mines by G. W. Jones, assistant gas chemist, Bureau of Mines; W. P. Yant, assistant analytical chemist, Bureau of Mines and O. W. Armspach, engineer, American Society of Heating and Ventilating Engineers.

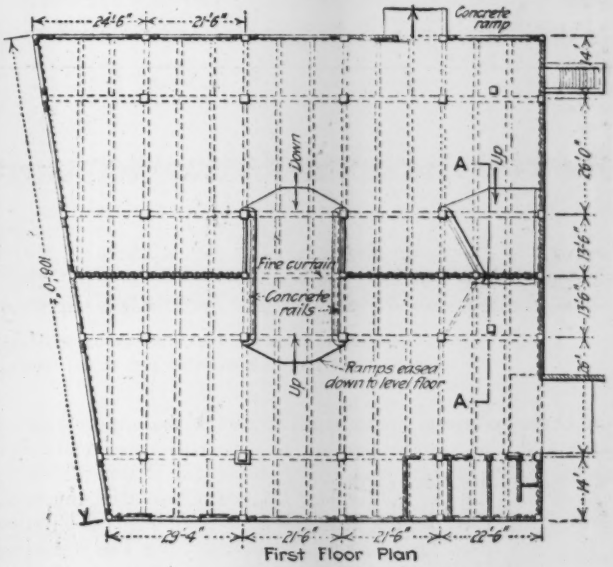


FIG. 2. PLAN AND SECTION SHOWING RAMP ARRANGEMENT

Floor plan of Nelson House Garage at Poughkeepsie. Construction is of reinforced concrete throughout, the beam-and-girder being used.

Collapse of Palm Beach Concrete Arch Bridge

Facts of Accident and Conditions of Work Reported from Inspection Made for Engineering News-Record —Pier Foundation Weakness Most Probable Cause of Collapse—Light Design Believed Contributory

TWO spans of a concrete arch bridge under construction at Lake Worth between Palm Beach and West Palm Beach, Fla., collapsed on Dec. 29 as reported briefly on page 35 of our issue of Jan. 5. Twelve hours after the first collapse a third arch failed. The fallen arches, each about 63 ft. in the clear, were part of a series of seven spans forming the easterly portion of a new highway bridge across the lake, replacing an existing timber trestle with steel draw. They were barrel arches with earth fill, and the filling was practically completed, the plan being to open this section of the bridge to traffic in temporary condition on Jan. 1. In spite of the advanced stage of construction, all seven spans were still on their centering, and this centering was supposed to be fully wedged up. The centering of four spans 10 to 13 are apparently undamaged and the centering under them does not appear to be disturbed.

At the time of the collapse the arch concrete was of various ages from 26 days up to two months or more, the collapsed spans being the youngest. The spandrel fill was being put in by hydraulic dredge pumping, the material being "sand" from the lake bottom. Filling was started at the east end and progressed westward span by span, rather than in uniform distribution. The preceding summarizes the essential points of the general facts available immediately after the collapse.

On account of the exceptional nature of this accident—failure of masonry arches and especially of spandrel-filled barrel arches being practically unknown—*Engineering News-Record* requested a Florida engineer with large experience in concrete work, R. F. Ensey, M. Am. Soc. C. E., of Eustis, to inspect the wrecked bridge and report on the facts and pertinent conditions. His report is given below.

FIGS. 1 AND 2. PALM BEACH BRIDGE—EAST PORTION, BEFORE FAILURE
At left, general view; at right, roadway surfacing in progress on Span 8.

the three collapsed spans vanished with the superstructure and the visible portion of the two intermediate piers. The bridge was being built for Palm Beach county by the A. S. Hecker Co., of Cleveland, under designs by Harrington, Howard & Ash, of Kansas City.

The collapsed spans were those adjoining the draw; the numbering being from the west end of the bridge, in which the draw was to be Span 6, they represented Spans 7, 8 and 9, with intermediate piers 8 and 9 (the draw abutment pier being pier 7). Spans 8 and 9 and pier 9, between them, fell in the first collopse, while Span 7 and its easterly pier 8 fell in the second collapse. Pier 7 remained in place, though the part above water is tilted eastward (*toward* the collapsed spans). The

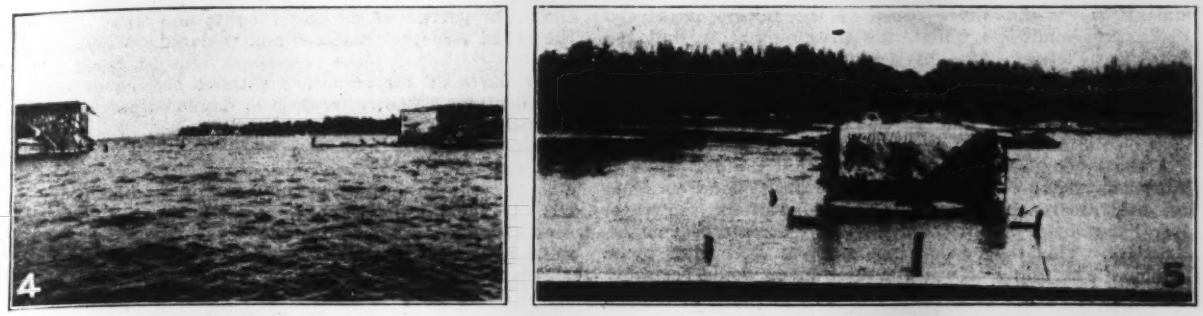
FIG. 3. CENTERING OF SPAN 10
Typical of all spans.

An investigation of the accident for the county by the designing engineers, who were also carrying out the supervision of construction, had been begun immediately after the accident. A formal report to the county by E. E. Howard of the engineering firm, dated Jan. 7, was made public on Jan. 9, and is reproduced directly following the present article. The engineers have advised us that a more technical report will be issued later.

History—Work on the construction of the bridge was begun on Sept. 12, 1921, under a contract let on a second bidding after the first bidding showed the bond issue of $250,000 previously voted to be inadequate. The contract price was $284,900. It was arranged to build the seven concrete arch spans east of the draw and the embankment or causeway forming the east approach this season, and have this part of the structure ready for traffic by Dec. 1, 1921, under penalty of $100 per day's delay. The period was later extended two weeks, and further delay postponed the anticipated time of opening to Jan. 1.

About noon on Dec. 29, the second and third spans from the draw, spans 8 and 9, collapsed and fell into the water. Span 7, next to the draw, was left standing alone. It is said that a seven ton road roller stood upon this span but was hastily removed after the collapse. About twelve hours later, in the middle of the night, this span also collapsed, pier 8 going with it, while pier 7, the abutment pier at the east end of the draw, was left in tilted condition, being tilted *toward* the collapsed section of the bridge.

Bridge Design—The structure was to consist of a 174-ft. steel swing span, five concrete arches and a causeway ap-



FIGS. 4 AND 5. TWO VIEWS OF COLLAPSED PORTION

At left, before failure of Span 7; at right, after failure of Span 7 (abutment pier in foreground, Pier 10 and Span 10 in background)

proach to the west, and seven concrete arches and a causeway approach to the east. The arch spans are 69 ft. long center to center of piers, giving a clear opening of about 63 ft. The abutment piers at the draw are 19 ft. thick and the others 9 to 9½ ft. thick, with tops 2 ft. under water, carrying skewbacks 6 ft. thick. The total length of bridge including causeways is 1,885 ft. The roadway is 30 ft. wide, and cantilevered sidewalks of 5 ft. each make the total width about 40 ft.

The arches are reinforced-concrete barrel arches, 12 in. thick at the crown and 24 in. thick at the skewbacks. The spandrel walls are reinforced, but are broken by expansion joints at the skewbacks and at two intermediate points in each span. The reinforcement of the arch ring consists of ¾-in. longitudinal bars 7½ to 15 in. apart, ⅝-in. transverse bars 4 ft. on centers in the lower face, and ½ in. transverse bars 8 to 12 in. on centers in the upper face. Dowel bars alternately 9 and 18 ft. long connect the arch barrel and the skewbacks. All reinforcement was deformed. The piers contained no vertical reinforcement, and apparently no bond was provided between skewbacks and piers.

Foundations—The piers were constructed in sheet-pile cofferdams, the material within which was dipped out with buckets and the bottom finally cleaned to rock with a 6-in. centrifugal pump. Concrete was placed under water by tremie; except in the case of the smaller piers the concreting was not continuous. According to the contractor's superintendent, two holes were drilled at each pier 6 ft. into the rock without going through it. The rock is a soft coral rock, into which usually steel sheeting can be driven and sometimes even pine piles.

Centering—Centering for the arches was designed and built by the contractor's superintendent. It consisted of timber framework founded on the piles of the old bridge, of the general type illustrated in the photographic view, Fig. 3, upon which were placed pony bents supporting the arch lagging. No braces, or practically none, were in evidence. The uprights of the centering were fitted up tight against the lagging supports, wedges being used in a few cases to take up slack. As already stated, all of the centering was in place at the time of collapse, though the side forms of the spandrel walls and the forms of the sidewalk cantilevers had been removed in large part.

Conditions After Collapse—The three arches, 7, 8 and 9 and the two piers between them are missing. Abutment pier 7 is standing, but tilted 21 in. toward the missing spans; the pier base, however, is not tilted, and there appears to be a separation in the pier below the water surface.

With the skewbacks gone, pier 8 is still in place, with top several feet under the water surface. Pier 9 has entirely disappeared; the cause of this has not been determined. Pier 10, now forming the west end of the remaining arch spans, stands apparently intact; a temporary fill of sand has been pumped against its west face to increase its stability.

The dowel rods between arch barrel and skewbacks pulled out of the arch concrete easily, especially at pier 7, where practically all pulled out clean. At pier 10 only six dowels pulled out.

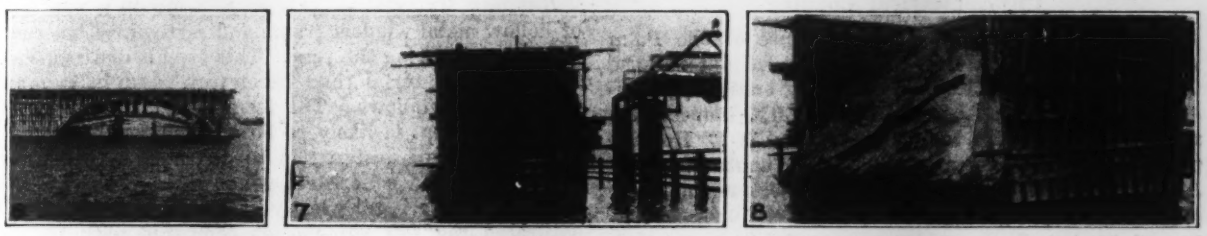
Inspection of the concrete suggests excessive use of sand with scant use of very poor larger aggregate. The concrete has, in fact, the appearance of mortar, in most cases. When first removed most of it could be crushed in the fingers. The proportions of the concrete are said to have been 1: 2: 3 for the piers, and 1:2½:3½ for the superstructure.

Comments on the Conditions Found—The design is of exceedingly light type. While no doubt it would be found of sufficient strength when completed, yet it affords scant leeway for contingencies of construction. It is questionable to the writer whether sufficient care was taken to determine the nature of the foundation upon which the safety of the structure depends. The uncertain nature of this coral reef is well known to the writer. In places it is not more than one or two feet thick, increasing in thickness abruptly or disappearing altogether. Instances have occurred where pine piles have been driven through it without difficulty.

Placing the pier concrete by tremie is apt to produce doubtful results, especially where the process is not continuous. It is probable that the tilting of pier 7 is chargeable to the existence of a joint between two successive days' work. It is to be noted that reinforcement in the piers might have aided materially in stabilizing the structure.

The concrete proportioning should have resulted in a satisfactory concrete, with good materials, mixing and placing. However, the concrete does not appear good.

Probable Cause—Without careful investigation of the conditions under the water at the site of pier 9, it would be



FIGS. 6-8. BEFORE AND AFTER THE SECOND COLLAPSE

At left, Span 7 before its fall; at center, Pier 7 after fall of span, showing its tilt toward the fallen span; at right, skewback end of Pier 7, showing reinforcing rods pulled out of arch-barrel concrete

difficult to fix the direct cause of the failure positively. From the conditions found, the presumption is that the cause is to be sought in the collapse of pier 9. I am informed by representatives of the contractor and engineers that no determined, systematic effort has been made to find out what became of pier 9, which would probably throw light on the failure if it did not reveal the cause.

A theory has been advanced locally that the disaster was caused by the successive filling of the arch spandrels from one end, causing an increasing wave of disturbance to travel over the structure until the distortion resulting became destructive. This theory does not seem to the writer to be tenable. The filling of one spandrel space would certainly result in setting up unsymmetrical distortions, but the filling of the next space would counterbalance these, and the arch would then function normally. The factor of safety should be ample to provide for these construction strains, and no permanently transmitted distortion would remain except in consequence of damaged foundations.

While the failure of pier 9 seems the most likely cause of the accident, contributory causes are to be sought in the following:

1—The unusually light type of design and reinforcement.

2—The poor quality of the concrete at critical points.

3—The doubtful nature of the foundation strata, which should have been rigidly developed at each pier over its entire extent.

4—The tremie concreting, and discontinuous concreting, in combination with the omission of vertical reinforcement in the piers.

Credits—I have to add that the information from which the preceding statements and comments have been compiled was obtained from interviews with the engineers' representatives, the contractor's representatives, and local officials, coupled with my personal inspection.

Engineers Report Collapse Due To Improper Filling Method

No Indication of Faulty Materials of Structure or Foundation Failure—Filling Caused Unsymmetrical Loading

AN INVESTIGATION of the collapse of the Palm Beach bridge on Dec. 29 was carried out for the county by the consulting and designing engineers, Harrington, Howard & Ash, of Kansas City, immediately after the failure. It was conducted by E. E. Howard of the firm, in co-operation with the contractor, the A. S. Hecker Co., of Cleveland. The report, made public by the Board of County Commissioners of Palm Beach county on Jan. 9, places the responsibility on unsymmetrical loading caused by the method of filling adopted by the contractor, and in effect, absolves the structure itself from all part in the accident.

The essential portions of the report follow:

We conclude that the accident and resulting damage was caused by improper method of placing the sand spandrel filling over the arch ribs. This filling was placed in a manner which produced unsymmetrical loading of the arches contrary to the stipulations of the specifications. This work was very hastily done as the contractor was pushing all operations with speed in an attempt to open this portion of the bridge to traffic.

There are no indications of faulty or deleterious materials of construction or of failure of supporting bed rock. It can be demonstrated mathematically that the method of placing the spandrel filling which was followed would almost certainly cause failure in such a structure which would be stable and perfect under symmetrically placed spandrel filling.

Part of Pier 7 now standing will have to be removed and certain imperfections in the under-water base concrete which have been developed will have to be repaired and the upper portion of the pier rebuilt; and other portions of the fallen structure restored and replaced. Work will proceed on the other piers and spans not yet begun and on other parts of the structure without change of plans or specifications. The restoration of damaged parts will probably be made toward the last of the job.

Complete record has been made of statements of those who saw the accident, of all observations, measurements, etc., as well as special calculations of loading conditions, etc. If you desire further information or a full technical report demonstrating the above conclusions we can have same ready within a short time.

Jan. 7, 1922. HARRINGTON, HOWARD & ASH,
Consulting Engineers.
By E. E. HOWARD.

Information received from Harrington, Howard & Ash subsequent to the date of the report just above states that examination of the foundations by diving revealed defective pier-base construction which contributed to the failure. An additional statement by wire supports the theory of unsysmmetrical loading:

Further anaylysis of arches under loading existing at faliure confirms views previously expressed but further investigation of effect of defective concrete mentioned in Mr. Howard's report is essential to determine the extent to which it contributed to failure. We plan to make a complete statement when investigations are finished.

HARRINGTON, HOWARD & ASH.

Kansas City, Jan. 20.

Test Work at Underwriters' Laboratories

EXTENSIVE test and research work was carried out at the Underwriter's Laboratories, Chicago, during the past year in connection with building materials and other items of engineering construction. The work included both investigation of the value of new materials and tests to check the maintenance of quality of old ones. Some notes condensed from a report just issued by the Laboratories follow.

Building Materials—Tests were made on a new type of hollow metal window frame and sash which has come to the front during the year. This type is distinguished by heavier material than heretofore used in so-called sheet metal windows. The term "steel plate window" applied to them is likely to be adopted by the Laboratories as a type designation to distinguish them from sheet metal and solid steel windows.

In roof coverings, greatly increased use of asphalt saturated rag felt shingles as compared with the old roll roofing was revealed by the test applications. Asbestos felt shingles are also being developed. These changes are considered to mean a decided advance in the fire protection afforded by roof coverings.

The manner of assembling, or form of construction, is in most cases a more important factor of fire resistance and structural strength than are the properties of the material itself. It is probable that for this reason the Laboratories will soon issue reports on the usual forms of wall and other constructions, giving their ratings in hours of fire resistance (1 hr., 2 hr., etc.).

In routine testing of small hardware it was found that sash chains do not seem to show consistent results in the yearly tests, but display excessive variation in ultimate strength. Door checks show quite uniform results on re-examination. Testing of safes grew to large volume during the year; it appears that standardization of test conditions will be necessary if uniform results are to be obtained.

Sprinkler and Hydraulic Fittings—About 4,500 old sprinklers taken from service were tested during the year. Investigation of breakage of dry pipe valves covered all of the valves on the market; modification of the design of some of the valves resulted from the work. Work on fire-pump controllers, additional hydrants and other important hydraulic appliances of fire prevention or fire fighting is under way and in prospect.

Gases and Oils—A great amount of work was done in tests of gasoline discharge devices, underground storage tanks, and fuel oil burners. Related work of investigation dealt with first-aid fire extinguishers, acetylene generators, gasoline lighting devices, gas producers, waste cans, fittings for dangerous liquids, hot-air furnaces, and gasoline-engine-driven electric lighting plants. The most important work in this range was done on first-aid hand fire appliances. A classification of these appliances was accomplished. Similar classifications of other devices investigated are likely to follow.

Electrical Work—Less work was done on standard wiring devices than hitherto, but more on a large variety of special appliances. Progress in development of standard appliances such as sockets, attachment plugs, snap switches, wire and conduits, seems to be almost negligible. Portable devices, however, developed great activity. A new form of portable cord, rubber sheathed cord, was developed during the year; it is expected to prove very useful under severe service conditions. Standardization of Christmas tree lighting outfits is in sight, to improve the trade of equipment available in this field. Much work was done on enclosed switches, a new product produced in response to objections to open-knife switches. Special testing machines for these switches were built.

Accident Prevention—Hazards in the newer household appliances, such as pressure cookers, sewing-machine needle guards, wringer guards, and the like required to be investigated. Boiler and elevator safety appliances demanded increased attention. Standards for tests of elevator limit stop devices were developed and brought into use. In the automotive field, work was done in four general divisions: Locking devices and test alarms, bumpers and safety fenders, classification of automobiles as to fire and dust hazards, and test of units and accessories such as rear traffic signals, heaters and head lamp lenses. Burglary protection developed into an active field of work during the year, nearly fifty new appliances and systems being examined.

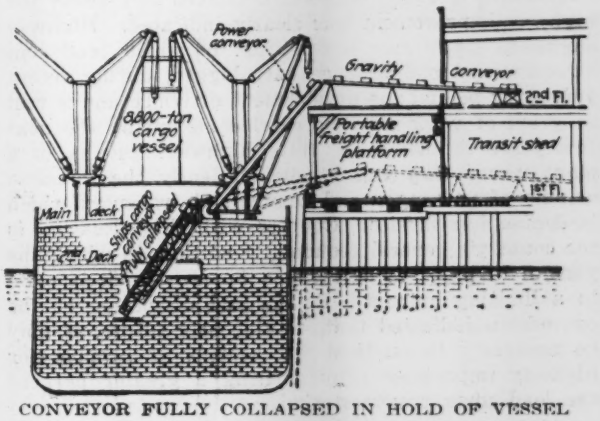
Electricity Production by Utility Power Plants

Electricity production at public utility power plants in the United States for the year 1920, according to the report of the United States Geological Survey for 1920-21, totaled 44,004,000,000 kw.-hr. Of this water power contributed 16,545,000,000 or 37.6 per cent, and fuel power 27,459,000,000 or 62.4 per cent. The increased output over 1919 was 13.1 per cent total, and the increase for water power was 13.3 and for fuel power 12.9 per cent. The fuel used in 1920 was 37,244,000 short tons of coal; 13,123,000 bbl. of fuel oil; and 24,702,000 M. cu.ft. gas, with percentage increases over the preceeding year of 6.1, 18.2 and 15.4. The statistics are based on monthly reports from utility companies having an output of 10,000 kw.-hr. About 95 per cent of the 3,900 power plants in this category made returns.

Telescopic Conveyor Halves Time of Handling Ship Cargoes

By G. F. Nicholson
Chief Engineer, Port of Seattle

A LABOR-SAVING device that will double the speed with which vessels can be loaded or unloaded has been developed by the engineering department of the Port of Seattle and will be put in service at that port in the near future. It consists of a compact conveyor which is lowered bodily into the hold of the vessel, its upper end resting on the hatch coaming. By means of a power operated extension that can be thrust out from or drawn inside the main framework, the lower end of the conveyor is kept close to that part of the hold where cargo is being stowed or unloaded. The conveyor is operated by electric motors served by leads from an energy source on shore and at its upper end delivers to or receives from the ordinary power conveyor.



CONVEYOR FULLY COLLAPSED IN HOLD OF VESSEL

The length of the conveyor extended is 45 ft. and when telescoped, that is, with the extension drawn in to the maximum, the length is 29 ft. The overall width is 5½ ft. and the overall depth 4½ ft. Unlike the ordinary conveyor it does not stand upon a truck and can be suspended or supported at any convenient angle. Extensible supports are provided so that the conveyor can be supported at both ends, at one end and the center, or at the two ends and the center. The weight is about three and a half tons which is easily handled by the ordinary ship's boom. The power equipment consists of a 10-hp., 440-volt a.c. induction motor, operating at 1,200 r.p.m. and an auto starter. Silent roller chain drives are used for both conveying and telescoping.

The capacity of the conveyor is roughly rated at 125 tons per hour with an operating speed of 75 ft. per minute. Previous to the adoption of this conveyor, for example, the rate of unloading salmon at Seattle averaged 800 to 1,000 cases per hour. With the conveyor the average rate is about 2,000 cases per hour. While designed primarily for handling cased goods, sacked goods of every description and bales of hemp, cotton, etc., up to 500 lb. in weight are handled. The maximum size pieces which can be conveniently handled are 2½ x 1½ x 5 ft. Larger or heavier goods can be handled by the ship's booms without interfering with the operation of the conveyor as it takes up only a small section of the hatch opening.

The estimated cost of the equipment is $2,400 per conveyor, including extension. Patent applied for.

Road Builders' Convention Stresses Financial and Administrative Sides of Highway Work

Need for Readjusting Sources of Revenue for Road Work Indicated—Material Prices Stated To Be Out of Line with Reduced Labor Cost—Tilt on Motor Vehicle Taxation—Research Results Reported

HIGHWAY financing occupied the top rung of interest in the program of papers and discussions—well balanced as to diversity of subject matter and of marked technical excellence—which the American Road Builders' Association presented at its nineteenth annual convention held Jan. 16-20 at the Coliseum, Chicago. With the road-building and maintenance programs of the 48 states involving the expenditure, exclusive of paving work within city limits, of $600,000,000 in 1921 and promising to reach a total of $720,000,000 for the current year, the need of a balance-sheet showing the relationship between outgo and sources of revenue for highway improvement was clearly indicated. Highway engineers today face a condition in which road construction and maintenance have lagged, during recent years, far behind the development of traffic and a vast program of work must be carried on during the next few years to bring the state highway systems to a point where they can handle efficiently the immense volume of passenger and commercial transport which is demanding service. Coupled with this situation is the country's general economic condition, in which the general taxpayer is carrying a burden which is close to a limiting amount. Papers and discussion at the convention indicated that, in the near future, it may be necessary to readjust the sources of revenue for highway improvement by shifting a greater part of the load upon transportation.

Technical Program Comprehensive

Among the score or more of other subjects considered at the convention, motor-vehicle legislation, traffic analysis and highway research were in the forefront. Design and construction, of course, received considerable attention, but interest in them, while keen, was clearly subordinated to those subjects which had to do with highway economics.

Attendance at the technical sessions ranged from 100 to 200 members, while the Good Roads Show, containing exhibits of 185 manufacturers of equipment and materials, requiring the entire available floor space in four buildings—the Coliseum, the Annex, and the Greer and Wilson Buildings—was the most impressive indication thus far offered in proof of the fact that road building has developed into one of the nation's big industries. A separate article dealing with the exhibit appears in the news pages of this issue.

The convention closed with the election of a nominating committee consisting of R. A. Meeker, Fred W. Sarr, W. D. Uhler, W. D. Sucro, and I. W. Patterson. If rumors which were current at the convention can be credited, there exists in the association's membership an element which feels that the organization is not assuming the position of leadership in the road-building field which the great opportunities before it make desirable. Some of the members feel that the association's work has expanded to such an extent as to justify the employment of a general manager and several assistants. It is expected that some action on this proposal will be taken at the forthcoming annual meeting this year.

With about 110 members and guests present at the first session Jan. 17 Col. H. L. Bowlby, president of the association, in his opening address, outlined the history of the organization and made a plea for closer co-operation among its members. Difficulty had been experienced this year, he said, in finding sufficient floor space for exhibits at Chicago, and unless conditions can be remedied before next year's convention, he indicated that it might be necessary to stage the event elsewhere than Chicago in 1923.

Bituminous Construction

Bituminous construction and the use of local mineral aggregate was the feature at the opening technical session on the afternoon of Jan. 17. H. W. Skidmore, Chicago Paving Laboratory, discussed bituminous foundations, stating that 15,000,000 sq.yd. of "black base" were in successful use today. He pointed to economies in this type of foundation by following the general practice of using 5 in. of "black base" as against 7 in. of concrete. Using information collected from contractors, he stated that a saving of from 25c. to 50c. per square yard could be effected by the use of bituminous instead of concrete foundation. In Providence, R. I., sheet asphalt has been laid successfully on both plain broken stone and bituminous penetrated base, and granite block also has been used on bituminous base.

Wider use of local materials as mineral aggregate was advocated by W. A. Welch, chief engineer, Palisades Interstate Park Commission, New York, who maintained that a leading consideration in the quality of mineral aggregate should be its freedom from fine silt and dust which prevent adequate binding with a bituminous material. Where soft aggregate is used, or the stone is brittle, too heavy a roller compacts the material so closely that penetration of the bituminous binder becomes impossible. Mr. Welch has had equal success with tar and asphalt as a binding material.

Simplification of specifications for asphaltic materials was advocated by L. M. Law, chief chemist, New Orleans Refining Co. The narrow limits sometimes specified for asphalt consistency, he said, increased costs and complicated the work at the refineries without resulting in a product of superior quality. Five-point limits specified for consistency, he believed, are too severe, especially in view of the fact that with ordinary laboratory methods errors of three points, either way, are common.

In his paper on "Specifications for Mineral Aggregates," Roy M. Green, Western Laboratories, Lincoln, Neb., pointed out an objection to what he termed "standardized specifications." Where such specifications are copied blindly by engineers in various localities, the use of local mineral aggregate is frequently precluded and the resultant cost of work increased.

Designating highway finances as the subject of outstanding importance in the road-building field today,

Thomas H. MacDonald, chief, U. S. Bureau of Public Roads, in a paper on "The Highway Outlook," emphasized the need of establishing a highway balance-sheet, national in scope, indicating the expenditures and the returns involved in the development of systems of highway transport throughout the states. Mr. MacDonald's address was, in effect, a broad economic survey of conditions as related to the nation's highway activities, and served as the keynote of a day's session given over largely to the consideration of highway finance. The highway outlook, Mr. MacDonald said, is not determined by any narrow or limited considerations, but by all of the broad social and economic relationships with which road development has intimate contact.

The United States, Mr. MacDonald believes, is facing a competitive industrial period such as has never before been seen. Beginning in 1914, a flood of needed internal improvements has been dammed back in cities both large and small, and includes the construction of buildings, highway improvements, water supply, and sewerage. In highway development, particularly, has the country lagged behind in proportion to the vast increase in the use of roads by motor vehicles.

In describing the national highway balance sheet, Mr. MacDonald placed on one side (1) Funds available; (2) the economic situation; (3) prices and costs for highway improvements. On the other he listed (1) Deferred highway improvements; (2) returns from highway investments; (3) need for easy and cheap transportation facilities.

During the year 1922 it is estimated that for construction and maintenance of highways, outside of city limits, $720,000,000 will be expended; unforseen limitations, however, may materially reduce this total. Expenditures during certain previous years have been as follows:

Year	Expenditures for Highway Construction and Maintenance
1904	$59,527,000
1914	240,263,000
1917	279,915,000
1918	286,101,000
1919	389,455,000
1920	500,000,000
1921	600,000,000
1922	720,000,000

An analysis of the sources of revenue for highway improvement during 1921 discloses the following apportionment: Motor vehicle license fees, 19 per cent; state road bonds, 7 per cent; local road bonds, 33 per cent; state taxes and appropriations, 12 per cent; federal aid, 14 per cent; county, township and district taxes and assessments 14 per cent; miscellaneous, 1 per cent. Of the expenditure during 1921, about $420,000,000 went into construction and $180,000,000 into maintenance.

Turning from highway finances to the general and economic situation, Mr. MacDonald quoted Secretary of Agriculture Wallace as saying that high freight rates, while not the only factor in the recent industrial depression, are a large one in retarding agricultural recovery. A condition which relates directly to highway financing is the one in which the farmer finds himself at present. In Iowa farmers are receiving for corn a price equal to only 65 per cent of the pre-war level; for oats, 61 per cent of the pre-war normal; and for cattle and hogs less than the pre-war normal. In addition they must pay for labor, 132 per cent; for rental on land values, 160 per cent; and for freight rates, 150 per cent of the pre-war level. There exists in the case of the farmer, therefore, a "spread" of from 60 to 70 per cent between what he receives for his product and what he must pay for his necessities. The purchasing power of the crops was stated to be lower today than at any time in the country's history.

The fall letting of highway contracts has been responsible, in large measure, for a reduction in labor costs on road construction, and the chief of the U. S. Bureau of Public Roads made the definite statement that state highway authorities now should not hesitate to let contracts for grading, excavation and similar low-cost types of work in the belief that present prices are not reasonable. Materials, however, have not taken their proper cut in cost, according to Mr. MacDonald. Producers of road-building material and equipment, he pointed out, must meet the lowered labor costs to a greater extent than they have in the past, if highway development is to proceed on the scale which traffic demands.

Illustrating how highway construction has lagged behind motor traffic developments, it was pointed out that between the years 1910 and 1921 the potential number of motor vehicles demanding highway service had shown an increase of 1,800 per cent, while the actual expenditures for the construction and maintenance of roads during this period had increased only 400 per cent.

As indicating the excess of deferred highway improvements, it was shown that in 1910, with 501,000 motor vehicles, highway expenditures totalled $120,000,000, while in 1921, with motor vehicles increased to a total of 9,750,000, the expenditures for highway construction and maintenance aggregated $600,000,000. Due to conditions, some of which, such as the war, were unavoidable, we have been "slackers" in road maintenance for the past half dozen years, according to Mr. MacDonald.

In concluding his address, the chief of the U. S. Bureau of Public Roads maintained that we cannot support a program of highway development as large as that of 1921 without redistributing sources of revenue. Such a redistribution might involve a reduction of taxes on property and an increase in taxes on transportation, in qualification of which Mr. MacDonald pointed out that by higher taxes on transportation he does not have specifically in mind an increase in license fees for passenger automobiles and motor trucks.

Figures presented by Mr. MacDonald showed that during 1921, deducting the amounts paid as motor vehicle fees and distributing the balance on a per capita basis, the cost of highway improvement for the entire country amounted to $4.40 per individual, equivalent, roughly, to a little more than 1c. a day.

Material Prices Out of Line

The discussion following Mr. MacDonald's paper brought out the fact that reduced labor costs for highway construction obtained generally on rural werk, but had not extended to so great an extent into the cities. A recent letting of $300,000 worth of gravel road in Oklahoma showed prices as low as those existing in 1914. A number of the speakers agreed with the statement that material costs, in comparison with the present reduced labor rates, were distinctly out of line.

Greater co-operation of all parties interested in the construction of roads was advocated in an address by William Ord, of the Lakewood Engineering Co. He

called upon the American Roadbuilders' Association to assume a position of leadership in this work, which would involve, he contended, the employment by the association of an able general manager and several assistants. An opportunity for co-operation, emphasized in the discussion by Henry G. Shirley, engineer of Baltimore Co., Md., is presented by the separate meetings of the American Association of State Highway Officials and the American Roadbuilders' Association. There bodies, he maintained, should meet at the same place and at about the same time, thus giving highway officials, engineers and contractors an opportunity of attending both meetings. As things now stand, attendance at one session often precludes that at the other, due to the time necessary and the expense involved in making two trips.

Motor Vehicle Taxation

The general subject of motor vehicle legislation, with particular reference to the matter of license fees or other forms of securing revenue, was treated in several papers and elicited a spirited discussion. D. C. Fenner, of the International Motor Co., indicated that the uniform vehicle law drafted by the Motor Vehicle Conference Committee, will probably be revised at an early date, such revision to take the form of a set of general principles in place of the specific detail which it now contains. His statement of principles regarding taxation was that the users of the road should pay for its maintenance, but that construction should be met by some form of general tax.

Prof. Arthur H. Blanchard, University of Michigan, endorsed the financing principle of payment of road maintenance costs by motor vehicle fees, leaving to the state or the county the financing of construction. Higher license fees are needed, in Prof. Blanchard's opinion, to discourage what he characterized as the "wild-cat" highway transport operator.

Decided opposition to Prof. Blanchard's statement of financial principles was voiced by A. R. Hirst, state highway engineer of Wisconsin, who maintained that the motor vehicle operators should participate in the cost of both construction and maintenance. He believes that an equitable distribution would result from placing one-third of the cost of highway construction and maintenance on motor vehicle operators and two-thirds on property in the form of some general tax. Mr. Hirst favors a tax on the valuation of a motor vehicle instead of on the basis of horsepower or gross weight, and in addition, a tax on gasoline. The one-cent gasoline taxes prevailing in about fifteen states, he said, are too low, and the prospect of gasoline taxes amounting to 5c. or 6c. per gal., in his opinion, are near at hand. Wisconsin has been engaged in a bitter fight over the subject of motor vehicle legislation. This year, he predicted that an increase in motor vehicle fees would be put through by the state legislature. The trouble in the past, he said, has not been with the man who owns or drives an automobile or truck, but with a few organizations of motor vehicle interests who oppose any changes in motor vehicle licenses irrespective of their amounts.

Following a paper on highway financing in Minnesota, by Commissioner C. M. Babcock, Charles M. Upham, state highway engineer of North Carolina, spoke on "The Business of a Highway Commission." The point of view he presented was that the state commission is an agency which "purchases" roads that can be maintained at minimum cost and at the same time furnish the tax payers satisfactory vehicle transportation, operated at minimum expense. Under a recently authorized $50,000,000 road-bond issue, North Carolina plans to place under contract this year work aggregating $20,000,000. Faced with the necessity of constructing a large mileage of highway, North Carolina has adopted the principle of building what Mr. Upham designated as "sub-grade" or "progressive type" roads. They are roads which are graded, provided with satisfactory drainage structures, and built with a sub-grade of selected materials—sand clay or top-soil—which will be used now to carry moderate traffic with the idea, at some future date, of constructing a hard surface pavement without loss of any of the previous steps in construction.

Experiments in North Carolina have indicated the desirability of improving the so-called sub-grade highways by placing upon their surfaces a single layer of 2-in. stone which is thoroughly rolled and then treated with an application of bituminous materials. Upon such a reinforced or armored sub-grade highway, according to Mr. Upham, can be constructed practically any hard-surface type which may be required in the future. In the meantime, a bituminous surfaced roadway is supplied, capable of carrying moderate traffic at a reasonable maintenance cost.

Brick Paving Changes

Brick and asphaltic construction were treated in two papers, the first by W. W. Horner, chief engineer, Sewers and Paving, St. Louis, and the other by Prevost Hubbard, chemical engineer of the Asphalt Association. After outlining the work which the National Paving Brick Manufacturers Association had done in reducing varieties of paving brick from 66 to 11, Mr. Horner discussed construction details from the point of view of economic cost. A 4-in. depth, he believes, provides all that is needed for the heaviest traffic, and a 3½-in. brick may be used to good advantage for moderate traffic. As for the brick only 3 in. in depth, Mr. Horner questions whether the reduced life of a pavement of this type is sufficient to justify the small saving in first cost involved in the reduced depth. Engineers generally, he believes, have been unable to approve the choice of the plain, wire-cut, lugless brick which has been the subject of so much controversy during recent years. Of the three types of bedding for brick pavement—plain sand, sand-cement and green concrete (monolithic)—the sand-cement mixture is considered the most desirable, regardless of the kind of filler used. On a concrete foundation Mr. Horner prefers a cement-grout filler, but on a flexible foundation or clay soil, a bituminous filler is preferable. The claim that the ease of penetration with bituminous fillers justifies the omission of lugs is not supported by Mr. Horner's examination of pavement and reports from engineers.

A triaxial diagram, designed as a quick means of determining the proper proportions of sand for sheet asphalt paving mixtures, formed the subject of Mr. Hubbard's paper.

Concrete Highways

In the session given over to concrete highways, Duff A. Abrams, of Lewis Institute, Chicago, stated that the maximum permissible size of coarse aggregate of

concrete in highway work is undergoing a marked change. Several years ago a size as large as 2 in. was considered radical, but now it is common to have aggregate of 3 in. or more in road work. Tests, as ordinarily conducted, for hardness, toughness and cementation value, in Mr. Abrams' opinion, are of little value, and laboratory determinations of wearing resistance have only a remote bearing on the actual wearing resistance of concrete roads in which aggregates are incorporated. Mr. Abrams sounded a warning against the taking of too small samples of material for testing. In the case of fine aggregate, he believes, a 50-lb. sample should be the minimum and in the case of coarse aggregate, 100 lb.

The life of a concrete pavement depends as much on surface finish as on any other factor, according to a paper by H. Eltinge Breed, consulting engineer, New York City. Care in securing smooth surfaces will reduce impact of vehicular traffic to a minimum and thereby produce a lasting pavement. There are, Mr. Breed has found, five causes of surface unevenness: (1) Foreign materials in the aggregate; (2) non-uniform aggregate; (3) poor workmanship in striking off and finishing; (4) cracks, longitudinal and transverse due to frost action, changes of temperature or unequal bearing power of the subsoil; (5) uneven joints, perhaps the most common cause of surface trouble.

The general remedies for surface unevenness are: More strict specifications, exacting good material and workmanship; use of steel reinforcement; division of the road longitudinally; and wide spacing of joints, with the use of dowels. Mr. Breed advocated the reduction of the number of transverse joints to a minimum through the use of longer slabs.

The discussion of Mr. Breed's paper brought out the danger from the employment of steel forms of too light a weight where a finishing machine is employed. The opinion was expressed, also, that the weights of many of the finishing-machines now on the market are excessive.

Highway Widths

Single-track concrete roads, treated in a paper describing work in Vermilion County, Ill., by P. C. McArdle, encountered decided opposition on the ground that any single-track route is inadequate for present-day traffic. The justification for the use of this type in the case of Vermilion County, Mr. McArdle pointed out, was a financial one, since it was necessary to connect the important towns of the county with funds which would have been inadequate had a double-track road been used. Mr. Hirst, of Wisconsin, raised the point as to whether any road should be designed to carry an odd number of traffic lanes, such as three or five. He was of the belief that where a two-lane road needed widening, provision should be made for four lines of traffic. The three-lane road was considered unsafe for traffic. It seemed to be the consensus of opinion that an 18-ft. road was the minimum for two lanes of traffic. The Wisconsin practice, where adequate funds are available, is to construct a durable type of pavement to a minimum width of 18 ft.; where the appropriation is small the road is not reduced in width but is constructed of a low cost type, such as gravel.

An analysis of the traffic census results made late last year in Connecticut, and described in the Jan. 12 issue of *Engineering News-Record*, p. 48, was presented by Dr. J. G. McKay, of the University of Wisconsin; this paper will appear in a later issue of this journal. Dr. McKay recommended the classification of roads, with maximum load limits specified in each case. The Connecticut result indicated that overloading of trucks was not restricted to any one group of commodities carried, thus controverting the theory that the bulk of overloaded trucks carry building materials, such as sand, stone or brick. A summing up of the results indicated that, so far as carrying capacity is concerned, 39 per cent of the Connecticut trucks were found to be overloaded; of this number, 37½ per cent were overloaded on the rear axle, and 40 per cent overloaded on the front axle. The figures indicated, also that 88 per cent of the motor trucks exceeding a gross weight of 25,000 lb., the Connecticut limit, were overloaded.

Research

Highway research was treated in three papers by Clifford Older, chief highway engineer of Illinois; Dr. W. K. Hatt, director of highway research, National Research Council; and A. T. Goldbeck, U. S. Bureau of Public Roads. The ground covered by these addresses was much the same as that in recent issues of *Engineering News-Record*.

The technical sessions were concluded by papers on study of gravels, by W. F. Purrington, New Hampshire Highway Department; cost keeping, by A. R. Losh, U. S. Bureau of Public Roads; and highway contractors' problems, by H. H. Wilson, of Winston & Co. Phillip Sharpless, of the Barrett Co., urged highway engineers against devoting all of their thought to the so-called high types of hard-surfaced road to the exclusion of the lower-cost types, which must be the main dependence in the less thickly populated sections of the country and which can be built economically with the use of local materials in most cases.

Resolutions

At its final session on Jan. 20 the convention adopted the following resolutions: (1) Endorsing the policy of federal aid applied to a definite policy of highways, as provided for in the Federal Highway Act of Nov. 9, 1921, and supporting the Woodruff bill (H. R. 8978) authorizing a federal-aid appropriation for roads of $100,000,000 annually for 5 years, beginning July 1, 1922; (2) condemning advertising signs along highways as a public nuisance and urging legislation for their elimination; (3) advocating grade crossing elimination and condemning the railroads for their "attitude of negation" in respect to such work; (4) objecting to present freight rates on road building materials as inequitable and calling upon the Interstate Commerce Commission and state railroad commission to review and revise existing rates; (5) endorsing the Advisory Board on Highway Research of the National Research Council and pledging support for a policy of efficiency and permanency in highway department personnel; (6) favoring a minimum width of 20 ft. for all trunk highways or roads carrying dense traffic; (7) commending the work of the association's president, Col. H. L. Bowlby; (8) expressing appreciation of the work of the U. S. Bureau of Public Roads and its chief, Thomas H. MacDonald; (9) commending studies of the relationship between subgrade, traffic and road surfaces; (10) favoring membership

for the United States in the International Road Congress; (11) urging the resumption of the publication of the U. S. Bureau of Public Roads' official journal *Public Roads;* (12) endorsing the centralization of road work in Alaska under an inter-departmental board.

Co-Operation Is Keynote of New Federal Highway Bill

Abstract of Address Given at Omaha Convention, American Association of State Highway Officials, by Thos. H. MacDonald

WE comprehend now as we have not understood in the past, the influence exerted upon our national life by transportation. To supply adequate and increased transportation facilities is the motive which has influenced the American people to increase the number of motor vehicles in use since 1910 more than 1,800 per cent. To provide the complement of the motor vehicle, the improved highway, is the underlying reason why the larger funds have been made available from state and federal sources. The proper combination of these two to serve a definite purpose in the nation's economy is highway transportation in the making.

Transportation Increase

More enlightening than any statistical quotation is the graphic picture of motor-vehicle registration and highway funds. The widespread opposition to state programs of highway building during the years from 1910 to 1916 when motor vehicles were pyramiding at an unforeseen rate, the increased funds made available following the Federal-Aid Act of 1916, the stagnation of actual expenditures during 1917 and 1918, the competition of industry of 1919 for materials, labor, and even more important, for rail transportation—all these have played a major part in producing the wide difference between the improved highways demanded by 9,300,000 motor vehicles and the new mileage constructed.

The record for 1920 and 1921 is better, but let each state highway department make plain to the people of its state that for less than three years of the past five since large funds became available, have conditions permitted highway construction on an increasing scale. The facts which are true of construction are true also of maintenance.

The conclusions are self-evident.

1. During the period 1910-1921, the potential number of motor vehicles demanding highway service increased more than 1,800 per cent; our actual expenditures for construction and maintenance increased about 400 per cent.

2. During the period 1910-1918, motor vehicles increased more than 1,100 per cent; highway expenditures 14 per cent.

3. During the period 1918-1921, motor vehicles increased about 700 per cent; and highway expenditures about 260 per cent. But even these figures do not truly represent the differential between the demands for highway service and our actual production.

Those who are a part of these organizations have the good fortune to be engaged in their chosen field when the greatest development that can ever come is taking place. The first two or three years of something more than a decade of major road building have passed. What has gone before has been largely preparatory. What will come after must be largely standardized, largely routine. The highway organizations that come after will not have such opportunities to render good, or, equally true, bad service, or be able to progress so far in a limited time in advancing highway engineering and administration, and in combining the motor vehicle and improved highways into scientific highway transportation.

It is not possible to define for a definite period of time the exact progress made for the United States as a whole, for there is no fixed point common to all the states. Yet, from the standpoint of highway service, I list our outstanding progress for the past two years in this order:

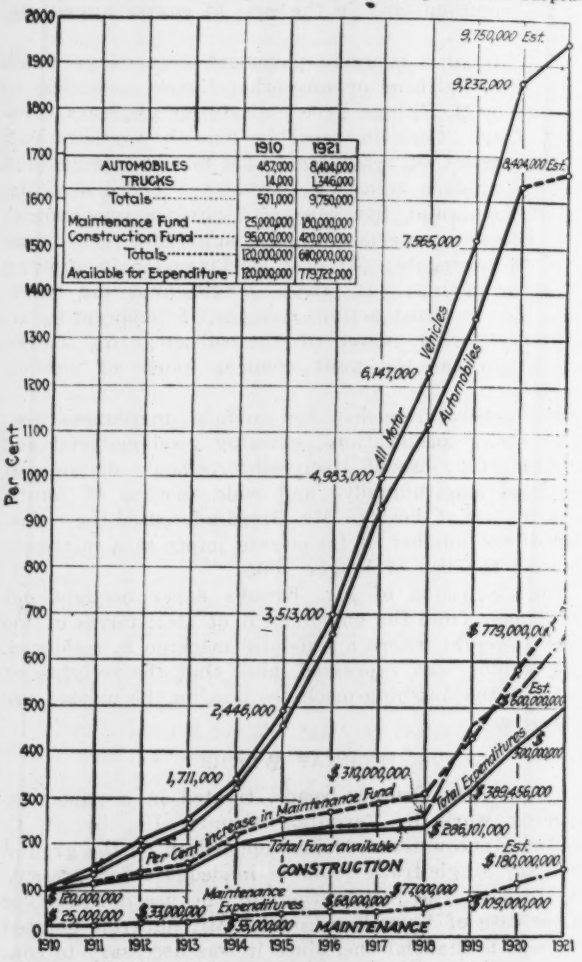
1. The increased highway service made possible through the establishment of proper methods and the expenditure of more adequate funds for maintenance.

2. The increased highway service resulting from new construction.

3. The adoption and enforcement of better engineering standards.

4. The improvement in the administration of highways as a public utility.

Although the new construction has been very large, the mileage of highways of all types that have been brought to a serviceable condition or restored after a period of inadequate repair, is still greater. The outstanding results secured from the distribution of the large quantities of war surplus materials and equipment are found in the better and more extensive highway maintenance made possible. The bureau estimates that by the end of the year war surplus



PROGRESS IN ROAD CONSTRUCTION AND MAINTENANCE COSTS AND AUTOMOBILES IN UNITED STATES, 1910-21

to the amount of approximately $150,000,000 in value will have been distributed for use in highway improvement.

As of Nov. 25 the records of the bureau show that of the total allotments to the states under the two first appropriations, $266,720,000, there has been placed under agreement with the sales federal-aid funds in the sum of $213,048,000 for 28,491 miles of highways. Of this mileage there has been completed the equivalent of 21,000 miles. You will note, therefore, that there now remains the balance of $53,702,000 to be placed under agreement from the old appropriation. From the new Federal Highway Act appropriation of Nov. 9, there was apportioned to the states $24,375,000 and $48,750,000 because available Jan. 1, 1922.

There can be no doubt as to the clear intent of the law to provide for a system of roads which shall include those which are now and which after improvement are to become

the major traffic lines. The different states of improvement to which the states have progressed, and all the variations between them of topography, of population distribution, of industries, of development of natural resources, must necessarily be reflected in the laying out of the system. These details must be worked out between the states themselves and between the states and the Bureau of Public Roads. Because of these wide variations, it is only possible to suggest some of the major considerations. We do not minimize the importance of the local traffic. To care for this class properly will, in general, always be the first objective of highway improvement. Our conception is rather that a choice of highways shall be made which, regardless of the order of improvement, will eventually join into a well-conceived network crossing both county and state boundaries.

As some of the principles which we must properly work out, the following are suggested:

1. The development of parallel lines to divide heavy traffic through thickly populated districts.
2. The development of direct, short-mileage routes, although on these routes there may now be a less amount of improved roads than on routes now followed.
3. The building of inner or outer belt lines around congested centers.
4. The reconstruction of weak sections for heavy truck traffic.
5. The widening of main routes near the largest cities or between cities where the distance is short enough to carry uniform traffic.
6. Proper connections with the routes of adjoining states.

Possibly there are many questions as to the future surfacing policies. The changes in types and specifications which will be sought from time to time by the bureau will be based upon the more accurate knowledge which is being obtained rapidly through research and through the detailed studies of the behavior of modern designs under traffic. The requirement of the 18-ft. surfacing is construed to mean that this is fixed as the minimum two-way road, where the construction is to be considered complete as first put down. This requirement will not preclude the building of a narrower pavement in those districts where the traffic does not yet justify the two-way width. I am yet to be convinced that we may not properly build now in many sparsely populated districts one-half of the final width of pavement in order to complete mileage between points, if all the other work is done to provide for the full width construction later.

Maintenance Provisions of Act

To insure maintenance, the strongest possible requirements have been written into the law. The department may not slight its responsibility, and the attitude of the whole national administration demands the utmost fidelity in the continuous upkeep of the highways built.

The bureau earnestly hopes that it will not be required to take over a single mile of highway for maintenance, but the responsibility is imposed, and this provision of the law will be enforced to the letter. It is a well-established principle that proper maintenance will result only if some form of patrol is organized that places direct and continuous responsibility upon someone for the condition of each mile of road, and the bureau will not consider that the states are properly living up to the requirements of this act until such a system is established.

Mutual Responsibilities Imposed

The Bureau of Public Roads will proceed under the provisions of this act on the assumption that each state will recognize the mutual responsibilities imposed upon the state and upon the federal organizations, and will bring its operations at once into harmony with all the provisions. Also, that each state will in fairness recognize the greater responsibilities, restrictions and requirements imposed upon the bureau. The bureau does not seek initiative. It does not seek to direct the states but to co-operate with them. There is now a plan of action for the guidance of both organizations that is so clear and so explicit that neither can escape the responsibilities imposed.

Referring once more briefly to the diagram, it is evident that a great misconception exists in the public mind as to the service which is being rendered by the highways. During the long period that construction and maintenance were lagging far behind the increase in traffic, it is not to be wondered at that our highways showed a material depreciation. Through the war period, with the greatly increased use of heavy traffic units, particularly at just the seasons of the year when the road surfaces are carried on weakened subgrades, some roads did break up seriously. But this depreciation in general has not continued, and more than this, the effect of the lag in maintenance has been practically obliterated by the increased maintenance during the past three years, and by the reconstruction of the weaker sections, until our roads are in a far better condition today than they have ever been in our history. This fact in itself controverts successfully any general accusations against our modern highways of failure to carry the loads imposed.

Provision for Transportation Paramount

The whole purpose of highway building is to make possible highway transportation, and the cost of the transportation must be reduced as low as possible. Therefore, restrictive legislation which limits too greatly the loads to be hauled on the highways should not be tolerated, as it is against a proper public policy. Legislation regulatory of the traffic on the highways should take into account that there are many factors which govern the traffic depreciation of our highways. Laws which blindly fix some maximum weight to be moved on the highways may prohibit the really profitable traffic and allow less economical and more destructive vehicles to operate practically unchecked. Both weight and speed are major factors in their destructive effects upon the highways, but the distribution of the load, the relation of the sprung and unsprung weights, the tire equipment—all have an important effect.

From the research of the past two or three years, and from the practical experience of the highway organizations, we are accumulating sufficient knowledge to engage understandingly on a determination of the character of legislation which will result in a sound public policy. The solution of highway transportation lies in the proper adjustment, no less of the motor vehicle to the road than of the road to the motor vehicle.

Because the system will for a long time be non-uniform in its carrying capacity, much discretion should be allowed the state highway departments in determining the loads which are to operate upon specific sections of highways, and further, much discretion should be allowed the departments in the making of seasonal restrictions where climatic conditions are such that there are periods when the roads, normally fully capable for carrying heavy loads, are for a short time carried on uncertain subgrades. Here is an opportunity for the highway builder and the motor truck manufacturer to co-operate to serve the public's interest.

Need To Preserve Existing Mileages

One other point is causing the public much concern. It is often stated that highways have gone to pieces and must be rebuilt. Engineers have been prompt to develop methods of improvement which are salvaging practically the full value that was originally invested in the highways. For example, some of the older macadam roads in New York State, lightly built, which are now heavy traffic lines, have been widened by concrete roadways on either side preserving a strip of macadam, say 6 ft. wide in the center, thus giving a 24-ft. usable surface by the addition of 18 ft. of new construction. The remainder of the macadam width is scarified and the material spread to form a better base under the new construction.

This is only one example of so many successful operations of like reconstruction that it may be taken as a principle that if roads are well maintained when traffic becomes so heavy that reconstruction is necessary, the major part of the investment can be preserved and be built into the new highway as an integral part. It is my judgment that our heaviest traffic lines of the future will be developed in this manner, for we must recognize the principle that at the present time the big task is to get a mileage of surfaces that can be maintained under the traffic. The principle that we should remember is to do the fundamental work right.

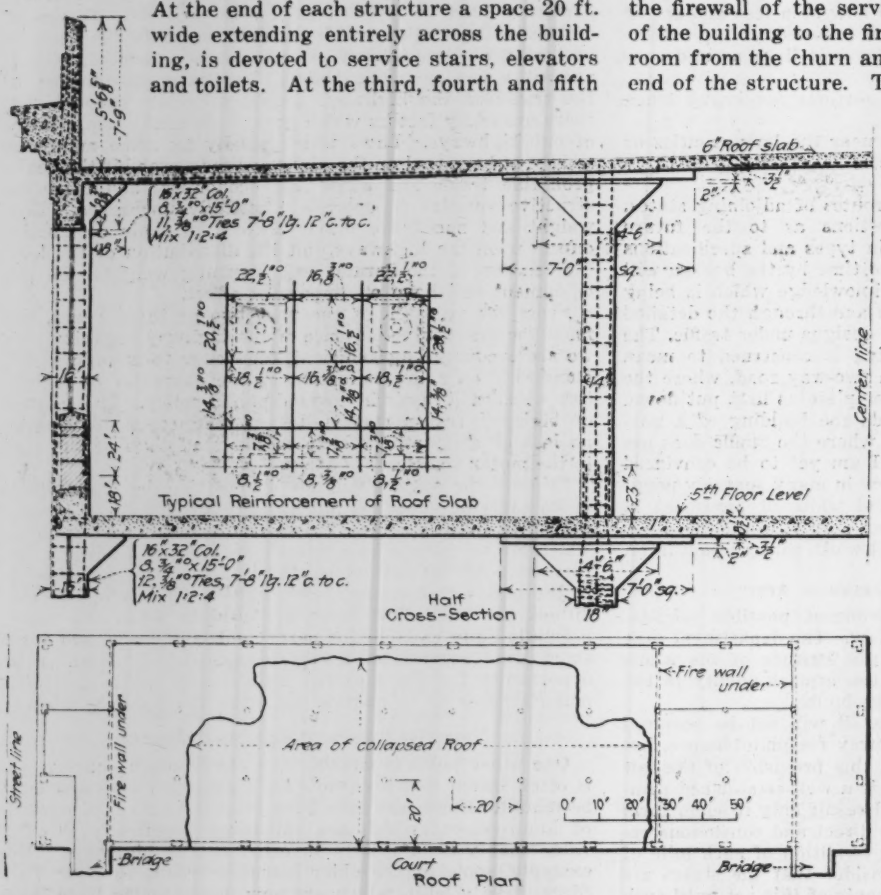
Liquified Rubber Fire Wrecks Concrete Roof

Highly Inflammable Liquid in Tanks Catches Fire and Severely Tests Strength of Reinforced-Concrete Building in New Haven—Construction Joints Planes of Weakness

By A. B. MacMillan
Chief Engineer, Aberthaw Construction Co., Boston, Mass.

ON THE evening of Nov. 30, 1921 a severe fire broke out in the top story of one of the buildings of the Seamless Rubber Co.'s plant on Hallock St., New Haven, Conn. The extent to which the structure, on the one hand, suffered damage and, on the other, resisted tremendous heat offers interesting material for study.

The main element of the Seamless Rubber Co. plant consists of three structures, each 240 x 60 ft. and each separated from its neighbor by a court 60 ft. wide. At the end of each structure a space 20 ft. wide extending entirely across the building, is devoted to service stairs, elevators and toilets. At the third, fourth and fifth stories these service areas are connected by means of inclosed reinforced-concrete bridges. Level with the second floor, the court between each two buildings is roofed with continuous skylights, which afford additional well lighted space for manufacturing purposes.



DETAILS OF RUBBER DIPPING BUILDING WHERE SEVERE FIRE OCCURRED

The construction of the plant throughout is of reinforced concrete, with brick spandrel walls under the sash, which is of steel glazed with clear glass. Partitions and fire walls are of tile plastered on both sides with cement plaster. The floor and roof design offers a typical two-way reinforcement flat slab with drop panels supported by round interior columns. The columns are spaced 20 ft. apart, on centers, each way, and divide the building into twelve bays longitudinally and three transversely. The drawing herewith shows the detail of that part of the building affected by the fire.

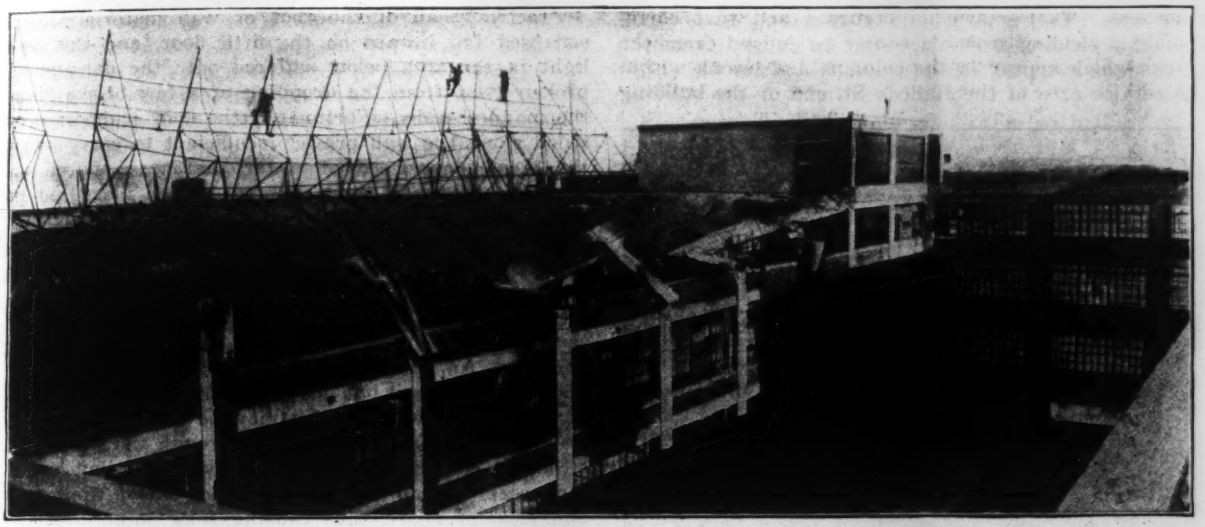
It is to be observed that the fire, which occurred in the dipping room on the fifth floor of Building No. 1, was confined to a limited area 160 ft. long by the width of the building. To be exact, it extended from the firewall of the service area at the Hallock St. end of the building to the firewall which divided the dipping room from the churn and the tank room at the opposite end of the structure. The dipping room where the fire occurred was devoted to the one process, used in manufacturing rubber gloves and other similar articles which are made by successive dipping of molds in liquified rubber.

Forty dipping tanks, each having a capacity of 600 gal. of mixed benzine, benzol, rubber and other ingredients, were located in this room. Into these tanks the molds on which liquified rubber was to be deposited were dipped and raised by specially devised mechanical apparatus. The hazard of a process which employed large quantities of highly explosive liquids was realized by the manufacturers. It was not the intention to carry on this process in the main plant. But, during construction, conditions arose which made it desirable to concentrate this process, with all others, in one connected group.

The buildings in addition to their precautionary construction were well equipped for fire fighting. A sprinkler system had been installed throughout which in time of need could draw water from a tank of 100,000 gal. Standpipes were placed at several places and were fed by two fire pumps each having a capacity of 1,000 gal. of water per minute at a pressure of about 100 lb. These fire pumps, further, were arranged to draw directly from the salt water of the harbor. In the department in question additional precautions were taken to remove inflammable gases by means of pressure and exhaust fans; and, as a further safeguard, the dipping room, churn room and tank storage room were all piped so that in emergency valves could be opened and each or all of the rooms be filled with live

steam. The possibility of utilizing the foamite system of fire fighting had been considered, and while it had not been adopted, tanks of the solution had been installed.

Yet, in spite of precaution, fire came. About 8:30 o'clock in the evening as the molds were being raised from one of the tanks, a minor explosion of gas occurred. It was instantly followed by a rush of flame which scorched the workman in attendance at the tank. The other men on the floor endeavored to put out the fire, but their efforts were vain and they were forced to abandon the room. Then the steam lines were turned on, the automatic sprinklers operated, the fire doors were closed and a general alarm was sounded. Shortly after the fire had gained headway the glass in the sash gave way, allowing free play to the wind, which was blowing vigorously against the long side of the building. This fanned the blaze into increasing violence.



LOOKING TOWARD TOP FLOOR OF WING AFTER THE FIRE

The firemen who fought the fire state that for concentrated fury their experience offered no parallel. It is reported that, not long after the beginning of the fire the top of the roof slab was bright red hot. The first signs of failure of the roof slab, however, became apparent several hours later, in the settlement of portions of the roof slab, a collapse which continued until the area shown in the drawing was wrecked. Several conflicting statements as to the time within which failure began have been received. These allow varying periods, from the third hour to the sixth hour after the fire began before any apparent signs of collapse were noted. It is possible that the exact sequence of effects produced by the fire will remain unknown; but in general the progression was probably much as follows:

The first influence of the intense heat would be to cause expansion in the roof slab, local at first, but gradually becoming general. If the statement made by the firemen that the top of the slab was red hot is ignored, and only objective evidence is credited, a temperature of not less than 600° F. at the top of the slab was reached. This is indicated in the fact that the pitch and felt forming the roof covering was reduced to a brittle cinder. Heat was approximately 600°, provided direct flame did not attack the roofing, would, I believe, be necessary to produce such destructive distillation of the roofing material.

Using the coefficient of 0.000006 for expansion and taking the normal temperature of the roof at not more than 70°; allowing the length of the heated slab to be 160 ft., we have $600° - 70° \times 160$ ft. $\times 0.000006$ which would mean a movement of the roof amounting to approximately 6 in., provided the surface was uniformly heated from one end to the other. Such extensive general heating probably did not obtain. On the other hand the degree of heat at the bottom of the slab was, without doubt, far in excess of the 600° suggested.

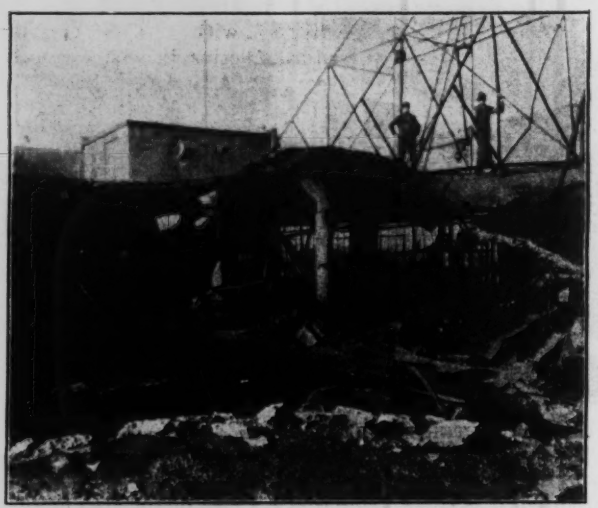
If the statement made by observers that the fire progressed successively from one tank to another is credited, it is conceivable that an area of the slab might be heated to a degree that would cause failure by compression of the concrete, provided the surrounding concrete acted as a restraining member and resisted the expansion of the hot area. The probability of failure would be augmented by the inequality of heat distribution through the slab. An intensity of heat greater at the bottom than at the top would cause more rapid and extensive expansion at the bottom of the slab than would occur at the top.

The tendency of such expansion would be to produce deflection at the center of the panels. Stresses in other members, such as the columns, and surrounding slabs acting to resist the movement of the heated area, would result. If we assume that an isolated portion of the slab may have been subjected to local heat, then it is apparent that the concrete in the isolated portion would have experienced combined stresses from bending due to its own dead-load acting as a beam, and direct thrust due to the expansion caused by the heat against the resistance afforded by surrounding concrete and steel. Considering the ability of the slab, acting as a strut, to transmit stress, it is apparent that bending, due to inequality of expansion and to the dead-load, would cause an eccentricity of the axis of the strut; and, as the least diameter of the strut cannot exceed the thickness of the slab it is

further apparent that its ability to carry load as a strut would be reduced in proportion to the length of the area heated.

If the ultimate strength of this concrete, which was composed of one part portland cement, two parts sand and four parts trap rock, be assumed at 3,000 lb. per square inch, and its modulus of elasticity at 2,500,000, then a change caused by an increase of one degree in temperature would result in a stress of 2,500,000 x 0.000006 or 15 lb., and an increase in temperature of 200° F. might be expected to overcome the ultimate strength of the concrete.

In so far as may be determined, however, failure of the concrete did not begin to take place until temperatures vastly greater were attained. This doubtless is due to the gradual yielding of various parts of the structure. That expansion occurred and that corresponding yielding took place may be judged from the cracks which appear in the columns and beams within the service area of the Hallock St. end of the building



NEAR VIEW OF FLAT-SLAB FAILURE FOLLOWING FIRE OF LIQUID RUBBER

which the flames did not actually reach. Owing to the conditions which existed at the time of my own visit, it was possible to make similar observations satisfactorily at the opposite end.

A second effect which may be noted is that the shafts of the round interior columns were invariably spalled badly just below the column head; and the columns that failed, and are not so covered up with debris that they may not be examined apparently gave way within about one-quarter of their height from the top, while a secondary break occurred one-quarter of the height up from the bottom.

It is reasonable to conclude that the weakening of the neck of the column, due to spalling under the intense heat, combined with eccentric stresses from the expansion of the roof slab, caused one or more columns to fail, whereupon the unsupported weight of the slab was sufficient to cause the gradual collapse of the other parts of the structure where heat was most intense.

That such conclusion accords with the facts is further supported by the position in which the various fallen fragments of the structure lie, and from the appearance of the bars which project from these portions still standing. These projecting bars exhibit tapering ends drawn to about ¼ in. in diameter by tension.

It is further interesting to note that the wall columns in falling fell in toward the floor. Without doubt the joints in these columns at the top of the wall beams, where pouring began formed a plane of weakness. The design drawings require the reinforcement in the fourth story columns to project thirty diameters into the fifth story above the joints at the wall beam, so as to form a lap with the reinforcement of the fifth story columns. The majority of the wall columns that failed did so through the pulling out of this lap. In the case of one column the bars did not actually pull out but were torn apart.

Ponded Water Safety Factor

Practically all of the roof or wall material which collapsed fell inward on the fifth floor, and the skylight in the area below suffered only the damage of broken glass from the dropping of a few bricks from the spandrel walls. Fortunately the floor scuppers provided along the wall proved insufficient to carry away the tremendous flood of water that was poured on the fire. Hence a pond collected, which measured in depth from the floor to the water line on the partition walls not less than eighteen inches. This providential pond probably prevented the burning naphtha from pouring out through the scuppers and spraying the surrounding buildings with unquenchable fire. It also served effectively in protecting the floor slab from damage. An examination of the under side of this floor slab disclosed but one longitudinal crack and that of little importance—which may be attributed to the fire. Virtually no water leaked through the floor slab, either at construction joints or elsewhere; but water did escape under doorways and flow down stairways and elevator shaft, thus causing some minor damage to materials in the plant.

The firewalls of plastered tile and the tin-clad fire doors which fixed the limit of the room area served their purpose effectively in stopping the progress of the fire. The surface of the fire-wall shows many craze cracks, but only in one or two places has the plaster been spalled. This may be attributed partly to the deep and generous keys in the face of the tile and partly to the fact that the covering plaster was composed almost entirely of portland cement and sand, only sufficient hydrated lime being added to make it workable.

The remarkable feature of the whole conflagration is that, despite the severity of the flames the resulting damage was confined to the actual area in which the fire originated. Hardly more than 10,000 sq.ft. of floor space out of a total of 300,000 sq.ft. in the plant was put out of commission. That such localization of damage could result under similar fire conditions with any other usual type of construction is unimaginable. Reinforced concrete has again met severe test and justified itself.

As the clearing of the debris of the damaged floor proceeds it will be possible to observe and to study more carefully the indications which will be revealed and hence to draw conclusions more accurate than any now possible. Yet it is fair to conclude that there is no fire fighting safeguard adequate to overcome the hazards of the dipping process and afford sure protection to the building where they are housed. Such

process should be completely segregated; preferably in one-story buildings, probably of timber construction, so situated that even if fire occurs adjacent structures will be protected both from communicated fire and from the effects of all too possible explosions.

Some Further Observations on the Rubber Company Fire

By J. Wm. Moffett
Chief Engineer, the Sperry Engineering Co., New Haven, Conn.

THE recent fire in the fifth story of the Seamless Rubber Co.'s Building No. 1 again demonstrated the futility of the word "fireproof" except in a relative sense, and the inefficiency of our modern fire-fighting apparatus under certain conditions. In this case the fire protection consisted of a wet pipe sprinkler system with the usual supplies, a steam jet system, and fire alarm boxes on each floor which promptly brought out the city fire department.

The fuel that fed the fire, a rubber cement with a naphtha vehicle in open tanks, was practically consumed before the fire was quenched. The high temperature maintained for several hours would have brought down any building structure no matter what the materials. An area of roof slab approximately 60 x 160 ft. collapsed, dragging down interior columns and the pilasters on the south side of the building. The pilasters on the north side remained standing undoubtedly due to lateral stiffness afforded by a cornice approximately 24 in. wide. There is no such cornice on the south side.

The sequence of events was apparently as follows: The flames from the tanks were more or less concentrated on the areas of the roof slab immediately above. The burning continued until the cement in the concrete was calcined and permitted the heat to reach the reinforcing bars. The bars were heated to a temperature at which they were drawn out to a pencil point by the dead load of the slab, whereupon they snapped and allowed large sections of the slab to sag.

The construction is flat slab. The flames were also attacking the interior columns at their highest plane of weakness or just below the junction of the shaft with the flaring capital. The photographs indicate very clearly what happened in the way of destroyed cement with spalling off of fireproofing on the outside of the 14-in. diameter columns. The great flexural stress caused by the sagging slab pulled over these weakened supports and dragged down the south pilasters at the same time.

The pilasters were 16 x 32 in. with eight ¾-in. round bars vertically and ⅜-in. round ties 12 in. on centers. The bars from the pilaster below were extended up about two feet to act as dowels for the pilaster above. The concrete on the outside face broke away leaving the dowels sticking up. The ties were put in as a single hoop. If there had been cross bonds or ties through the center of the member this individual item of the failure might perhaps have been retarded.

Those who advocate cable clamps for bonding reinforcing bars probably would consider this good material. If the bond between the dowels and the main reinforcement had been positive, the cantilever beam action in the column would have been maintained until either the elastic limit of the outside bars had been reached or the concrete had failed in compression at the inside face.

It was of interest to note along the main lines of fracture of the slab the free ends of many rods as well as the tapered ends of the broken bars. As noted above, the concrete along these fractures was so friable that the trap rock aggregate could readily be picked out and the sand matrix crushed between the thumb and finger.

The concrete in the floor slab on which the fire occurred was apparently not greatly damaged, probably due to the protection of 12 to 18 in. of water from sprinklers and fire hose. The scuppers in the side walls must have been partly choked with the rubber cement, some of which floated on the water. There are several cracks which developed mainly along center lines of columns.

Large cracks opened in lintels at both east and west stair towers at the ends of the building, mute witnesses of the great expansion of the building under high temperatures. It seems strange that more well defined cracks are not in evidence in the pilasters supporting the fifth floor.

A remarkable feature in connection with the fire is that 6-in. terra-cotta partitions, with ½ in. of cement plaster on each face, served as effective fire walls at each end of the flame swept section. A standard three-ply tin clad fire door, although warped out of shape, and a pair of Kalamein doors with the wood under the metal covering deeply charred, held back the destroyer of the concrete structure. [Further data on the fire in this building appear in the *Quarterly* of the National Fire Protection Association, Jan. 1922.—Editor.]

Municipal Construction Cost Records Must Be Kept in Minnesota

CONSTRUCTION cost records of all municipal work in Minnesota over $1,500 in amount are made compulsory by Chapter 274 of the 1921 statutes. This act was originally drafted by the Northwestern Association of General Contractors. It applies to cities, counties and all other political subdivisions of the state. Under the act, whenever any political subdivision decides that any public work or construction is necessary, whether it is to be done by day labor or by contract, an estimate of the cost must be made and if the estimate exceeds $1,500 then the actual figures must be published in the official newspaper. When the work is carried out cost records must be kept and on completion these records must be published. The records and accounts must be open to public inspection at any reasonable time and certified copies of the same must be supplied at cost to any citizen who desires them and pays the required fee. The statutory provision as to the nature of the cost records is as follows:

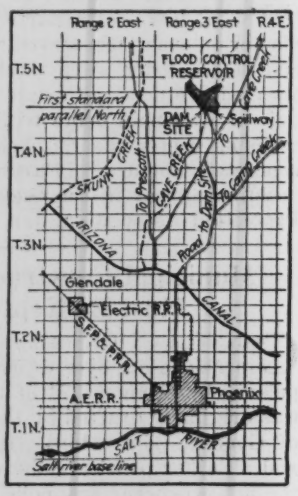
> The said account shall show in accurately tabulated form, under appropriate heads, the totals of all classes, kinds and descriptions of work performed and of materials entering into such public work or construction, and the cost to such municipality, political subdivision or public agency of each, including the cost of all materials, supplies and services furnished or paid for by said municipality, political subdivision or public agency, and the cost of all labor, when said work or construction is done by contract the prices paid to the contractor for, and the amounts paid to him for each class, kind or description of work performed, and materials furnished; and in all cases, the cost of all overhead, the cost of engineering, and all other expenses involved in the total cost of such public work or construction, which total shall be tabulated and distinctly shown.

Progress on Flood Prevention at Phoenix, Ariz.

Joint Bodies Interested in Control of Cave Creek Perfect Plans for Construction of Multiple-Arch Dam

FOLLOWING the flood in Cave Creek at Phoenix, Ariz., on Aug. 31, 1921 (*Engineering News-Record*, Sept. 15, 1921, p. 464) steps were taken toward controlling the flow in the stream by the construction of a dam in its headwaters. James B. Girand, of Phoenix, was put in charge of the work. Progress on the project to date has been obtained from him, as follows:

Cave Creek has a drainage area of about 210 square miles, and is rarely in flood; disastrous floods are probably three to five years apart. The creek loses itself on the desert just north of the Arizona Canal where its channel disappears and it is spread out over a considerable area extending from a point west of Glendale to the western portion of the city of Phoenix. The last disastrous flood occurred during the past summer, and while the damage was variously estimated at from $50,000 to $500,000, it was probably nearer the former. It broke the main Arizona canal in twenty-one places and deposited a considerable amount of silt in this canal which necessitated cleaning it out at considerable expense; it also covered some of the fields with silt and destroyed crops in others. The water stood about 2 ft. deep at the state capitol building and flooded the basement, causing considerable damage to records stored there.



PHOENIX, ARIZ., AND VICINITY, SHOWING LOCATION OF CAVE CREEK CONTROL DAM

It is proposed to stabilize the flow to a maximum of 1,500 sec.ft.; it was thought that the peak of the last flood probably reached 33,000, but only lasted for perhaps thirty minutes. The reservoir created by the dam will contain approximately 13,000 acre feet, with natural spillway about one mile east of the dam-site. The dam is some 1,700 ft. long.

It was originally intended to build an earth-fill type of dam, but it is now proposed to build a multiple arch. Bids were asked for the earth-fill type, of a design made by the board of engineers appointed by the various parties in interest, which parties consist of the state, because the state house was directly in the path of the floods; the county, because of the roads and bridges in the path of the floods; the city, because of the streets and irrigation ditches in the city; the Salt River Valley Water Users Association, because of its main line canals and numerous laterals; the Paradise Verde Irrigation District, which project is in an embryonic stage, but is situated north of the Salt River Valley Project and which contains a considerable area, directly in the path of the floods from Cave Creek. Added to this, of course, is the interest of the public who have their homes, farms, etc., in the vicinity.

In asking for bids the board insisted that bidders might submit alternative plans. There were only four bids received from two different contractors, and only one bid on the dam as designed by the board. As this bid practically exhausted the appropriation, the contractor's earnest money was returned to him.

Lynn S. Atkinson, of Sacramento, submitted two bids, one for the earth-fill type of dam and the other for the multiple arch, which had been designed by John S. Eastwood. The bid of the latter design was accepted by the control board, and Mr. Atkinson is now preparing to enter into a contract with the board to begin its execution. The location of the dam with relation to Phoenix and the surrounding country is shown in the map herewith. The dam site is reached by paved road to the Arizona Canal, and then a fairly good cross-country road, the total distance being about 22 miles. The dam will contain some 18,000 to 20,000 cu.yd. of concrete, with 42-ft. bays and an extreme height of some 60 ft. above the present bed of Cave Creek, with footings extending to an impervious cemented conglomerate of varying depths up to 28 or 30 ft. It is to be provided with control gates and automatic siphons.

Supervision of construction is in charge of Mr. Girand, who is operating directly under the board of engineers appointed by the various parties in interest, as stated above. They are: V. A. Thompson, city manager, for the city of Phoenix; Thomas Maddock, state engineer, for the state; Harry Vernon, county engineer, for the county; C. C. Cragin, chief engineer, for the Salt River Valley Water Users Association, and E. W. Michaels, for the Paradise Verde Irrigation District.

Why Engineers Should Join State Engineering Societies

IN a letter of appeal to the engineers of Iowa, J. H. Dunlap, president of the Iowa Engineering Society, included the following reasons, aside from the technical aims, why all engineers should become members:

The chance to serve the state by assisting in the work of such committees as the committee on legislation, the committee on professional practices, the committee on standard contracts, services and fees. Proper laws, proper professional ethics, proper services in return for fees, all need your active co-operation.

The chance of becoming acquainted with the members of a society numbering 550 members, scattered over the entire state, through attending annual meetings, district club meetings, council meetings and committee meetings. What engineer should sentence himself to a hermit's death so far as knowledge of his technical brethren is concerned?

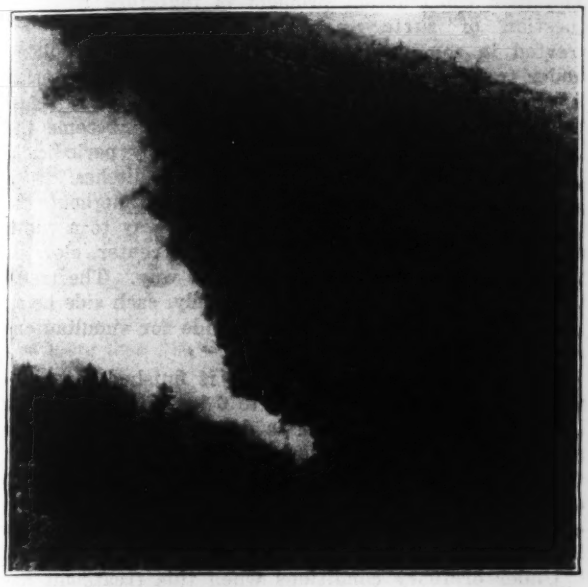
The chance of helping to interpret the engineer to others and to himself by wise methods of publicity, so that his services may be in proper demand. Why do your brothers have to accept work in competition with each other and at cut-throat prices? What are you doing to increase the service of engineers, in order that increased recognition may result?

The chance of furthering good citizenship in local communities by directing our district clubs into ways of increasing service. Why not conceive a community as a big engineering enterprise, and then do your part to assist in directing the enterprise? To whom does this government belong, to you, or to the other fellow? Why disenfranchise yourself and become a man without a country, by neglecting to assume the responsibilities as well as the privileges of citizenship? Are you passing the buck at this point, indulging in the famous American game?

Airplane Forest Patrol Makes Good Western Record in 1921

IN VIEW of the discontinuance of the appropriation which made possible the co-operation of the Air Service and the Forest Service in patroling forested areas by airplane, interest attaches to the results of the past season's work in spotting forest fires from the air. The effectiveness of air patrols equipped with radio, is shown by the statement of the Forest Service that during the 1921 fire season in California of 595 fires reported by airplane, 288 were "spotted" within one-quarter of a mile of exact location and 422 had been reported to Forest Service men within ten minutes after discovery. In Oregon this season 653 fires were reported. Of this total 482 were reported by radio from airplanes and of these 339 were reported to Forest Service stations within ten minutes of discovery by the aërial observer.

It is now pointed out that radio compasses at the



VIEW OF FRESHLY STARTED FIRE FROM AN AIRPLANE

landing fields could be used very effectively in locating a plane circling over a fire. With radio compasses at two or more ground stations whose distance of separation is known, the exact position of the fire could thus be readily located on the map. This plan would obviate the necessity for an observer in the plane, as the pilot could easily trip an automatic transmitter that would operate while he was over the fire. The season's experience in California has shown that radio amateurs for operating the ground stations can be readily secured.

Many instances are cited to show the superiority of airplane observation for this work as compared to the lookout stations maintained by the Forest Service: in case of large conflagrations Forest Service officers can be taken for aërial reconnaissance, thus saving invaluable time in organizing the fire fighting forces. Where necessary serial photography may be used as an aid in planning method of attack. In the case of small fires in rough country the aërial observer can spot the location more accurately and usually quicker than the "lookout" or observer stationed on a mountain peak. These mountain stations, however, are to be continued even if the plan of air patrol is again made possible.

Research in Civil Engineering as a Career

Large Possibilities for Benefit to the Community—Field for Activity Wide—Governmental Research Agents Underpaid

By Alfred D. Flinn
Chairman, Division of Engineering, National Research Council

CIVIL engineering is less commonly in mind in connection with research than are electrical, mechanical, chemical and metallurgical engineering. Nevertheless, new facts about materials and methods and other data on which to base the safe and economical design, construction and maintenance of the great variety of structures embraced in the practice of the civil engineer are much needed. Research in civil engineering fields as a career distinct from professional practice, offers fewer opportunities for immediate connection to the manufacturing industries with the possibilities for inventions and patents, so often alluring to young men. Possibilities for benefit to the community, however, are large, although yielding less tangible commercial rewards.

Yet civil engineering in its greater projects utilizes, in some measure, all results of research in mathematics, physics, chemistry and other branches of science and the developments in the more specialized fields of engineering. Need for research in civil engineering subjects has been less keenly realized because so many of these subjects have come to be commonplace. Everyone feels contemptuously familiar, for example, with the dirt we tread beneath our feet, but many an engineering structure has failed, or has been more costly for lack of real knowledge about various kinds of earth. We need to know much more about the earths as the support under foundations for highways, railroads and structures; about earths as materials for dams and dikes; about the pressure of earth against retaining walls, and about the movement of earth in landslides. We need to know more, also, about the art of constructing foundations with regard for the supporting earth or rock.

Fields For Research

Transportation of goods and passengers on highways, railways, waterways, and airways, demands thorough restudy for it is being profoundly affected at this time, by invention and by sociological changes. Not alone the structural features of the ways of transportation and the vehicles used thereon, demand improvement, but the broad economic and social problems connected with transportation need fundamental examination.

Harbors and railway terminals, with all their appended facilities, have many problems of great consequence unsolved in the modern sense. Here again there are not only physical problems, but questions of economics and of the organization of our great communities.

Hydraulics, although a field in which there has been much experimentation, has numerous problems for which better solutions are desired, especially for application on large scale. Such problems relate to stream control, water-power development, aqueducts, pipe lines and sewerage systems.

American engineers pride themselves on their wonderful steel bridges and skyscrapers, but much ignorance is concealed in every one. Occasionally some great disaster sounds a warning that more and better

knowledge is needed. A judicious combination of experiments and mathematical studies might improve our systems of design and methods of construction leading to greater safety and economy.

Portland cement has come to be one of the most important engineering materials. Not enough is known about its manufacture nor its use in concrete for many purposes. The chemist and the mineralogist should co-operate with the engineer in extending the studies already made, of which there have been many.

Town, city and county planning have been popular fads with engineer, architects and reformers in recent years. While the subject has received some serious study, the underlying principles deserve to be the subject of much more thorough research than has been expended upon them. Several novel solutions of our great community problems have been offered. Their examination and further attempts to solve these problems demand broad and thorough knowledge of many branches of civil engineering, economics, government and sociology.

Disposal of sewage and trade wastes demands research so that our sources of water supply and our rivers and harbors may be protected from dangerous and offensive pollution, and that the pollutions which have already been perpetrated may be ameliorated. For research in this field, co-operation of engineers, chemists and technologists is requisite.

Civil engineering devotes its attention chiefly to subjects of immediate utility to mankind. This desire for foreseen and definite utility distinguishes the work of engineer experimenters and students from much of the work of scientists, particularly in so-called fundamental research. The subjects mentioned are only examples which have occurred to the writer as illustrative of the opportunities and needs for research in the fields of civil engineering.

Research in civil engineering has been done in many instances by special assignment incidental to large engineering projects or through the enterprise of some individual who has either supported himself in the work or obtained special support from some benefactor. Professors of civil engineering in the technical schools conduct some researches in connection with their courses of instruction or on special engagements. Such governmental organizations as the Bureau of Standards, the Reclamation Service, and a few of the state bureaus, have men more or less constantly engaged in research in civil engineering. A few salary rates of the Bureau of Standards are given as examples of those paid by governmental organizations. This bureau has only a small number of men engaged in research in civil engineering. The salaries of these men range from $1,400 to $4,000 a year. Those carrying on independent researches receive between $3,000 and $4,000. This present scale of salaries is admittedly not adequate compensation for the work. In special research assignments, in private or corporate offices, compensation is determined by the importance of the work or probable value of results, or is simply the salary, already fixed by other considerations, of the member of the staff selected for the research assignment.

Support for research in civil engineering is less likely to be found in industrial establishments than for research in electrical, mechanical or chemical engineering. Men who enter the civil engineering field of research must, apparently, be supported by universities or endowed institutions or technical societies, or be employed by federal or state governments. Patentable inventions are less frequent and less likely to yield large returns in civil engineering than in other branches. Knowledge gained in early years devoted to these studies, should give men of proper natural capacities equipment of great value for the higher practice of the profession, with consequent broader possibilities for usefulness and commensurate rewards.

Silt Roads Periodically Flooded To Maintain Wearing Surface

ALMOST the entire area of the Imperial Valley in Southern California is covered with a deposit of very fine Colorado River silt, many feet in thickness. Rainfall is rare (about 2 in. per annum) and the topography of the valley is uniformly flat; the maximum slope of the ground seldom exceeding 1 or 2 ft. per mi. The road construction problem is therefore wholly a question of surfacing. Unless the roadways are treated in some way, the dry silt grinds up quickly under traffic and wheels sink deeply into soft material. A large percentage of the roads in the valley are below the level of irrigation canals and it has become the custom to maintain a wearing surface by periodically flooding the roads with water from the ditches.

The practice in road construction throughout the irrigated territory is to grade the roadway to a width of 40 or 50 ft. with a flat dike in the center, elevated from 12 to 18 in. above the traveled way. The traffic uses either side of the road alternately, each side being graded to a width sufficient to provide for simultaneous travel in both directions.

When the grading or scraping is finished the roadway is flooded to a depth of 3 to 6 in. from the nearest irrigation ditch and travel is diverted to the opposite side of the roadway. After the water has soaked away and the road has become nearly dry, it is leveled with a very large blade leveling machine drawn by a traction engine and is then dragged with a correspondingly large drag until the surface is smooth and hard.

Under ordinary conditions when this treatment has been completed the road is in excellent condition and will remain so from three to six weeks or longer, according to the amount and kind of traffic.

Surfaces that have been finished in this way can be used safely for automobile speeds up to 35 mi. per hour. When the wear has been sufficient to break through the crust formed by the water treatment chuck holes appear and the surface breaks up rapidly. The traffic then has to be diverted to the other side of the roadway and the flooding process repeated.

Occasionally, through accident or carelessness in irrigation, both sides of the roadway are simultaneously flooded. The roadways are then practically impassable and traffic has to take to the top of the central dike. Under this condition frequent delays are entailed because the dikes are ordinarily made wide enough for one-way traffic only.

Prevalence of Typhoid in England and Wales

The total number of cases of typhoid fever reported in England and Wales for the year 1920 was 3,109. For a population of 37,426,800 this gives a rate of 8.3 per 100,000. Typhoid deaths in 1920 were 520, or 1.4 per 100,000.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Exclude Extra Fine Aggregate

Sir—In his letter in your issue of Jan. 5, 1922, p. 33, Professor Hatt comments on the use or crushed limestone and crusher dust, in place of sand for concrete, in connection with the failure of concrete construction where such fine aggregate was used. At the end of the letter he states that he has submitted this question of disintegration of concrete where such aggregate is used to various chemists without a solution.

It seems to me that the question is not one altogether of chemistry. The way I see it is as follows:

Crusher dust is composed of a large percentage that passes a 200 sieve and of course a larger percentage through a 100 sieve. Properly ground cement has specified percentages of material passing these same two sieves, viz.: 75 per cent and 95 per cent, respectively. The difference between the two materials is that one is properly calcined or burnt while the other is not.

The mixtures for concrete are so proportioned that the cement will completely fill the voids left by the next courser material. When, however, crusher dust is permitted to be used in the mixture, it displaces the cement, which only in part is used for cementing the mass, while the remainder simply adds to the mass. The result is that when exposed to the weather the limestone dust is freed and separates out from the concrete, causing disintegration.

The remedy is to specify that no fine aggregate (or say no more than 3 per cent) that passes through a 100 sieve shall be used in concrete.

M. HIRSCHTHAL,
Concrete Engineer.
D. L. & W. R.R.

Hoboken, N. J.
Jan. 12.

Information Desired on Bridge Floor Fires and Prevention or Protection

Sir—Your issue of Dec. 29, 1921, carried a news item (p. 1078) with reference to the proposed work of the joint committee which has been formed to consider fire-protection principles as applied to wooden highway bridges and bridge floors, and mentioned the fact that the committee desires information on the subject of floor fires from engineers who are connected with the design and maintenance of highway bridges. May I be permitted to use the columns of your paper to explain the matter more fully and, in behalf of the committee, to make a further appeal for the co-operation of those engineers who may be able to furnish desirable data?

The possibilities of this study were first suggested by disastrous fires which have occurred on long steel bridges and the committee is therefore particularly interested in various types of wooden floors on steel spans but it also has a general interest in all types of timber bridge construction, for it is felt that some of the principles involved may apply as well to timber trestles as to steel trusses.

Some of the points which have been suggested for consideration are as follows:

1. Prevalence and importance of bridge fires. This applies particularly to the thousands of comparatively small country bridges, as fires on important bridges are usually reported in the technical press.
2. Causes, usual points of origin and spread of bridge fires.
3. Descriptions of bridge fires and the bridges on which they have occurred.
4. Methods which have been used for preventing fires or for rendering timber construction more fire-resistant.
5. Provisions which have been made for fighting bridge fires.
6. Differences which may have been noted between plain and creosoted material.
7. Types of floor construction which appear to have fire-resistant qualities.
8. New ideas for practical methods of fire prevention, fire fighting, or to render timber construction more fire-resistant.

It is the hope of the committee that it may be able to secure a comprehensive discussion of the various points involved in this important subject, to the end that conclusions may be reached which will be of value to engineers who are responsible for the safety of bridge structures.

Communications may be addressed to the writer, who is acting as secretary for the committee.

E. F. KELLEY,
Senior Highway Bridge Engineer.
Bureau of Public Roads.

Washington, Jan. 6

Age Effects Account for Molded vs. Core Concrete Strengths

Sir—The article on the "Relation Between Molded and Core Concrete Specimens" by H. S. Mattimore, in *Engineering News-Record*, January 12, 1922, on p. 73 bears on a problem that is of considerable interest and importance at this time.

I am rather surprised however that an engineer of Mr. Mattimore's caliber and broad experience in testing work should find in the data listed any evidence of a tendency toward higher strengths in cored as compared to molded concrete specimens and can only believe that other data must have influenced his interpretation. The apparent difference may be more logically explained by a study of the relative ages of the test pieces when broken. For instance the average strength of the 100 molded specimens in Table I is 2,724 lb. per square inch at an average age of a little over 19 days while the average of 4,665 lb. per square inch for cored specimens corresponds to an average age of 243 days.

The importance of the normal effect of age may be readily seen in the following Table which is derived from Table I of Mr. Mattimore's article by combining results on test pieces of approximately the same ages.

TABLE A—VARIATION OF COMPRESSIVE STRENGTH WITH AGE

No. of Spec.	Ages Included Days	Average Age Days	Log. of Age	Mean Compressive Strength
41	7	7	0.845	2,096
59	28-30	28	1.447	3,162
16	60-90	77	1.886	4,540
25	140-150	146	2.164	4,622
47	300-330	306	2.485	4,695
12	400-460	420	2.625	4,764

It should be noted that the first two items of this table represent molded specimens and the balance cored ones.

D. A. Abrams in Proceedings of the American Society for Testing Materials, 1918 Part II, shows that the compressive strength of concrete approximately follows a straight line relation with the logarithm of its age. That the data of Mr. Mattimore's Table I also follows this rule fairly closely is apparent from a study of the last two columns of Table A above. This relation may be roughly expressed by the equation

$$S = 1{,}650 \log a + 700.$$

where S is compressive strength in lb. per square inch
a is the age in days.

Prof. Abrams article includes several typical empirical equations derived from published experimental data, among them being

$$E = 1{,}400 \log a + 150$$
$$\text{and } S = 1{,}900 \log a + 1{,}500$$

Since the equation which approximately fits Mr. Mattimore's data is almost the exact mean of these, it seems unnecessary to seek further for an explanation of the difference between the strengths of cored and molded specimens in this particular case.

FRED KELLAM,
Testing Engineer.
Indiana State Highway Dept.

Indianapolis, Ind.
Jan. 14.

NEWS OF THE WEEK

New York, January 26, 1922

Bill Extends Time To Complete Hudson River Bridge

Having been assured by Senator Calder that the financing of the proposed bridge across the Hudson River from New York to New Jersey can be arranged and that the engineering problems involved have been worked out, the Senate has passed the bill introduced by Senator Frelinghuysen, which extends the time for the completion of the bridge until fifteen years from the date of the measure's passage.

Details concerning the proposed bridge were contained in *Engineering News-Record*, May 26, 1921, p. 900.

"Good Roads Show" Needed Four Buildings to House Equipment of 185 Exhibitors

Heavy Material-Handling Machines Vie with Pavers, Trucks, Tractors, Locomotives and Other Transportation Equipment

The greatest aggregation of road-building equipment and materials ever gathered together was on exhibition at the National Good Roads Show held Jan. 16 to 20, inclusive, in Chicago, in conjunction with the nineteenth annual conventional of the American Road Builders Association, the technical features of which are covered in another article on p. 152 of this issue. Indicating the trend of present road-building requirements, heavier, larger and better built machinery was the rule. Material-handling equipment predominated. Rarely have so many locomotive cranes, steam and gas shovels, draglines, heavy graders and hauling equipment in the form of industrial locomotives, motor trucks and tractors, been seen along with concrete mixers, road rollers and asphalt plants. No less than six makes of industrial locomotive vied with motor trucks for their share of the haulage business. Multi-cylinder gas engines were much in evidence for more general use than before.

Of the changes in equipment shown the greatest advances, perhaps, were not spectacular but were confined to a simplification of older models, increased sturdiness, greater size and a more liberal use of cast steel instead of cast iron and cut gears for cast gears. "Not a piece of cast iron in this machine," was the boast of more than one exhibitor.

NEW MACHINES

Of the new machines the following are noted: Lakewood brought out a belt distributor for the concrete mixer in its "Master" 28-cu.ft. paver. The 30-in. belt delivers the concrete in 30 sec. over a swinging steel boom, 20 ft. long, at the end of which is a deflector spreading the concrete from the 2-ft. height over a 4-ft. swath. The same company showed an auxiliary hand-operated belt finishing machine with a substantial bridge. The Austin Machinery Corp. exhibited a rotary subgrader about 4 ft. in diameter which carries the earth in adjustable scoops to a transverse belt which, in turn, delivers it beyond the side forms over which the machine travels. A new bucket loader with positive feed and special wheel grips was also shown by Austin. Koehring had on display its recently built heavy-duty locomotive crane. Lee had a new low-hung automatic dump body for a Ford chassis. Numerous truck and body companies showed new arrangements for quick dumping.

Most of the mixer manufacturers, Koehring, Chain Belt, Austin, Foote, Lakewood, Smith, Ransome and Oshkosh, had 21-cu.ft. pavers operating and reported substantial inquiries and some sales during the show.

Attendance at the Coliseum showed a total registration of about 6,000. To give a more comprehensive idea of the show, photographs are shown on another page. A complete list of exhibitors is given below, together with notes of a canvass by staff members of *Engineering News-Record* of the equipment or materials shown in each booth. Four buildings were utilized, the Coli-

Associated General Contractors Hold Annual Convention

Budget of $175,000 for 1922 Approved—Standardization of Equipment and Construction Methods Undertaken

Contracting plans to do its own housecleaning. It will extend its work of standardizing contracts and construction practices. It will continue to strengthen its policy of co-operation in all constructive movements toward stabilizing industry and of co-ordinating organized engineering and organized contracting. These decisions were the outcome of three days' active discussion and committee work by the Associated General Contractors convening at Cleveland, Jan. 17-19. Nearly 200 delegates representing 26 states took part in the proceedings.

QUESTIONABLE PRACTICES CONDEMNED

A demand upon the association to answer the challenge that contracting had been remiss in not eliminating the vicious conditions disclosed by the investigations of the Lockwood Committee in New York and the Daily Committee in Chicago was made almost at the start of the first general session. Quoting the editorial in *Engineering News-Record*, Jan. 5, 1922, p. 4 it was contended that the perfunctory action of the association indicated a failure to grasp its opportunity to cleanse its own skirts and to appreciate its public duty. It was stated that until the association came forward with a definite program, backed by positive action, it had better eliminate the word "integrity" from its motto. Direct accusation was made that the officers of the association had been delinquent in their duty. This accusation was challenged and the records were presented showing that every positive instruction of the association had been carried out by the officers and that no member of the association had in the two investigations named been cited for indictment or even seriously threatened for complicity in vicious practices. In reply it was asserted that the association virtually failed in its duty when it merely contented itself with the fact that its own members had evaded criminal prosecution. A proper conception of its duties, it was asserted, required positive assistance in punishing the criminals and direct aid in exposing and correcting corrupt practices. As the result of the discussion the resolution was adopted that the

(*Continued on p.* 171)

Mid-West Highway Officials Announce Cement Boycott

Executive officers of the state highway departments of Illinois, Iowa, Kansas, Michigan, Minnesota, Missouri, South Dakota and Wisconsin, members of the Mississippi Valley Association of State Highway Officials at the Chicago Conference Jan. 20 and 21 by resolution pledged themselves "not to make any contracts for highway construction involving the use of cement, except the few contracts for work which cannot possibly be postponed, until the manufacturers have fixed the price of cement so that road construction is not unduly penalized because of its magnitude, its urgency and its popular appeal, which price should be and must be in harmony with the reduced price now in effect for all other basic commodities."

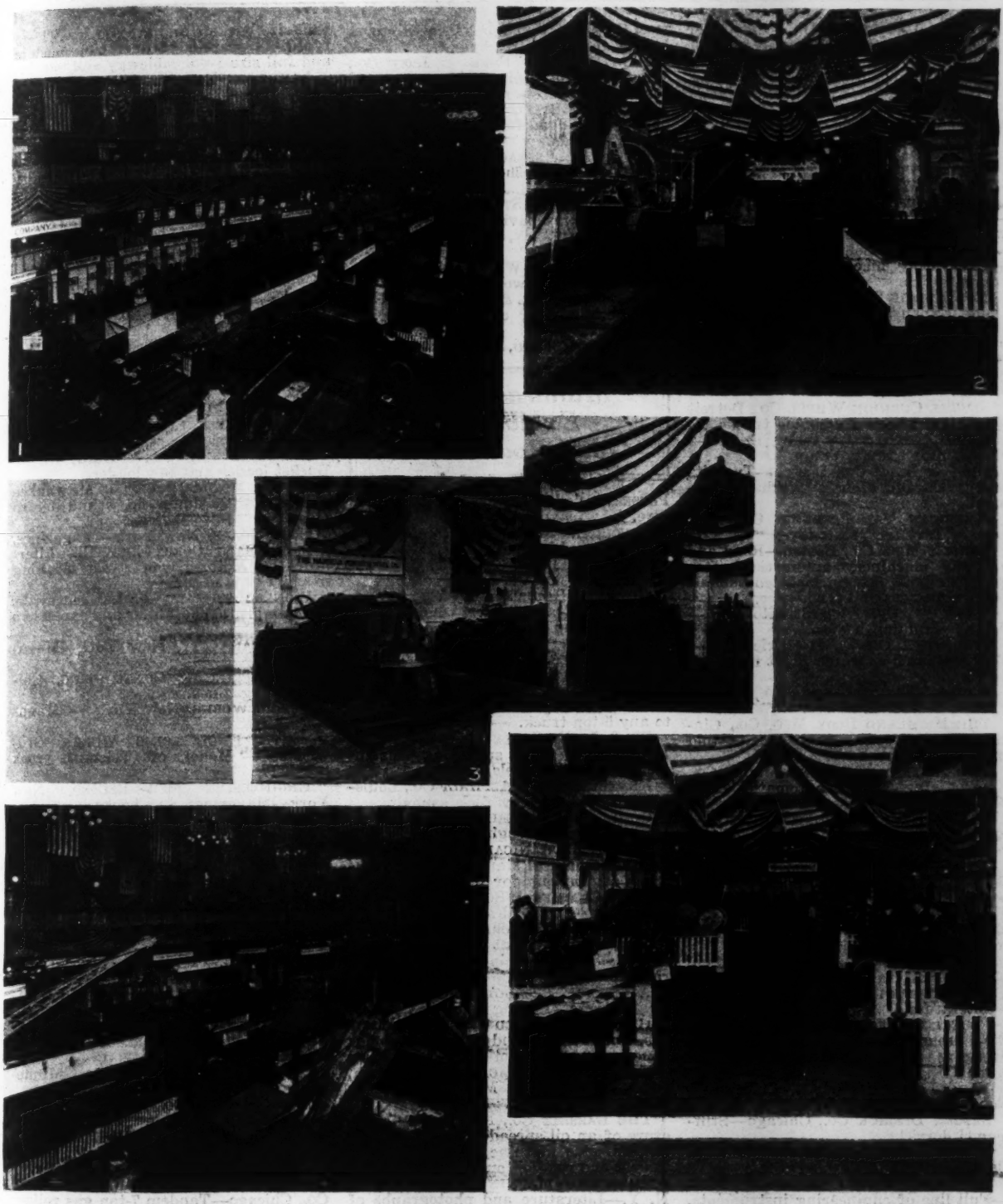
The resolution further recommends immediate investigation, in states where it can be done, of the possibility of erecting and operating state-owned cement mills.

An appropriation of $5,000,000 was made by the last legislature of Illinois for the construction of a cement mill, but so far no definite move has been made.

Low bids of $1.60 per barrel at mills, recently submitted to the Illinois and Wisconsin highway departments, have been rejected.

A resolution calling for a reduction of freight rates on stone and gravel aggregate was adopted.

Heavy Construction Plant, Good Roads Show, Chicago



1. Motor Trucks in Coliseum. 2. Large Size Pavers in Greer Building. 3. Tractor Section in Wilson Building. 4. Material Handling Machinery and Pavers in Coliseum. 5. Motors and Tractors in Coliseum Annex.

seum, the Annex, the Greer and the Wilson Buildings, adjoining. Photographs were taken in each building.

U. S. BUREAU OF PUBLIC ROADS, Washington, D. C.—New Strainoscope for determining the effect of impact on bridge members; map of U. S showing distribution road-building rock with stone samples on horizontal map; field and laboratory testing apparatus; charts and illuminated colored photographs of road tests; large illuminated map of Illinois roads completed and under way in state system; photographs of Federal aid roads; soil pressure testing apparatus; magnifier of colloid particles, 5,000 + times; miniature models of various types of roads.

METAL FORMS CORP., Milwaukee — Metal form road rails and models of culvert forms.

C. H. & E. MFG. CO., Milwaukee—Mounted triplex pumping outfits, 1-yd. rear drive truck tractor with automatic dump body.

KIPP CULVERT CO., Minonk, Ill.—Culverts.

HIGHWAY ENGINEER & CONTRACTOR, Chicago—Magazines.

CHICAGO MOTOR CLUB, Chicago — Chart on prevalence of accidents.

MORAND CUSHION WHEEL CO., Chicago—Cushion wheels for motor trucks.

BUDA CO., Harvey, Ill. — 4-cylinder gasoline engines, jacks, power unit for auxiliary power purposes and steam turbines for headlights.

HASTINGS PAVEMENT CO., New York, and ASPHALT BLOCK PAVEMENT CO., Toledo, Ohio—Asphalt block floors.

SAFETY MUSHROOM LIGHT CO., Milwaukee—Street-intersection lamps.

WILLITE ROAD CONS. CO. OF AMERICA, Chicago—"Willite" road pavement.

LARCO WRENCH & MFG. CO., Chicago —"Speednut" wrench and Cockran pipe wrench.

BUCYRUS CO., South Milwaukee, Wis. —Excavating machinery, steam, electric, gasoline.

THE BURCH PLOW WORKS, Crestline, Ohio—Expansion cast-iron culvert pipe, stone spreaders and distributors, stone unloaders and road plows.

THE CONNEAUT SHOVEL CO., Conneaut, Ohio—Hand shovels, scoops and spades.

SEWELL CUSHION WHEEL CO., Detroit —Cushion wheels for motor trucks.

AUTOMATIC UTILITY CORP., Detroit— The Winsor gravity dump.

BUFF & BUFF CO., Boston—Transits and levels and other surveying equipment.

AMERICAN TAR PRODUCTS CO., Chicago—"Tar-Mac" road tar.

KINNEY MFG. CO., Boston—Road and highway machinery automatic heater and distributor, steam jacketed asphalt pumps, flushers and tar kettles.

ANTHONY CO. INC., Streator, Ill.— Automatic dump bodies.

ERIE STEEL CONST. CO., Erie, Pa. — Multiple batch charging plant for truck haulage.

HANDY SACK BALER CO., Cedar Rapids, Ia.—Sack balers.

THE HIGHLAND BODY MFG. CO., Cincinnati — Wooden dump bodies and truck cabs.

THE AMERICAN CEMENT MACH. CO., Keokuk, Ia.—Mandt automatic dump bodies and Boss mixers.

EASTON CAR & CONSTRUCTION CO., Easton, Pa. — Scoop bodies, industrial railway equipment.

THE WALLIS BOILER CO., Chicago — Boilers for portable use, a tubeless boiler.

AMERICAN GAS ACCUMULATOR CO., Elizabeth, N. J.—Danger signals and road "lighthouses."

INDUSTRIAL WORKS, Bay City, Mich. —Industrial cranes.

CLAY PRODUCTS ASSOCIATION, Chicago —Literature.

ROBERTSON BROS. MFG. CO., Chicago— Steel road strips, spiral lock seam dredging pipe and Burrell railroad signal.

PAUL J. KALMAN, INC., Chicago — Concrete reinforcing bars.

SASGEN DERRICK CO., Chicago—Stiff-legged derricks.

CARBIC MFG. CO., Duluth, Minn. — Carbic lights and Carbic cakes.

KEUFFEL & ESSER CO., Hoboken, N. J. —Full line of engineering instruments.

WYOMING SHOVEL WORKS, Wyoming, Pa.—"Red edge" shovels, scoops, spades and picks.

BALL ENGINE CO., Erie, Pa.—"Erie" steam shovels and cranes.

ELECTRIC WHEEL CO., Quincy, Ill.—E. W. C. power unit and a new E. W. C. traction and mounting equipment.

HYATT ROLLER BEARING CO., New York—Roller bearings.

VAN DORN IRON WORKS CO., Cleveland, Ohio—Truck products, hoists and dump truck bodies.

PAN AMERICAN BRIDGE & CONSTRUCTION CO., LTD., Chicago—"Lee" Simplex bridge and "Lee" road plane.

HELTZEL STEEL FORM & IRON CO., Warren, Ohio—Universal tamper, and forms for concrete road work.

NATIONAL STEEL FABRIC CO., Pittsburgh, Pa.—Steel fabric for reinforced-concrete roads.

AMERICAN REFRACTORIES CO., Pittsburgh, Pa.—Crushed granite from Devils Lake, Wis.

INTERNATIONAL STEEL TIE CO., Cleveland—Roadway paving guards.

PIT AND QUARRY, Chicago — Magazines.

THE JENNISON-WRIGHT CO., Toledo, Ohio—"Kreolite" wood blocks.

AMERICAN STEEL & WIRE CO., Chicago —Wire fabric for concrete road reinforcement.

SERVICE BUREAU, AMERICAN WOOD PRESERVERS' ASSN., Chicago — Literature.

AMERICAN HIGHWAY EDUCATIONAL BUREAU, Washington, D. C.—Literature.

THOMPSON BROS. CO., Chicago—Danger signals.

HIGHWAY HOIST & BODY CO., Edgerton, Wis. — Mechanical hoists and gravity dump bodies for contracting work.

SHUNK MFG. CO., Bucyrus, Ohio — Grader blades.

FOX ROTARY SNOW BROOM, Newark, N. J.—A rotary snow broom attachable to any 5-ton truck.

W. & L. E. GURLEY, Troy, N. Y.— Engineering and surveying instruments, transits, levels, etc.

KENTUCKY ROCK ASPHALT CO., Louisville, Ky.—Kentucky rock asphalt.

CLIMAX ENGINEERING CO., Clinton, Iowa—Industrial engines.

HOUGH MECHANICAL HOIST CO., Chicago—Mechanical standard hoist, high-dump attachment, for road building.

F. D. CUMMER & SON CO., Cleveland —Literature of road asphalt plants.

GALION IRON WORKS & MFG. CO., Galion, Ohio — Giant premier grader, sectional cast-iron pipe, gas and steam road rollers.

AMERICAN PRODUCTION & TRADING CO., Chicago—Rolling dump bodies.

HADFIELD-PENFIELD STEEL CO., Bucyrus, Ohio—4-ton and 7-ton 4-cylinder American gas locomotives.

EAST IRON & MACHINE CO., Lima, Ohio—Miniature of Merriman asphalt plant.

THE BARRETT CO., New York—Miniature of an oil spreader and automatic lantern slide machine, showing use of Tarvia and road oil on highways.

ACME ROAD MACHINE CO., Frankfort, N. Y.—Literature and photographs of steam road rollers.

BEACH MFG. CO., Charlotte, Mich.—A working model of a new dragline bucket of the bottomless type and a new mounted hoist with LeRoi engine.

JENNINGS AUTOMATIC DUMP BODY, ING., Roanoke, Va. — Models of dump bodies.

W. S. TYLER CO., Cleveland, Ohio— "Hummer" electric screens and "Ro-Tap" testing sieve shaker, testing sieves and automatic "Stop-rite" time switch.

SAUERMAN BROS., Chicago—Working models of drag-line cableway and tower. Full-size buckets and accessories. Three types of scrapers in operating models and full size 1-yd. cableway and bucket.

LAKEWOOD ENGINEERING CO., Cleveland, Ohio—New hand-finishing machine shown in operation, finishing machine, sub-grader, a Master 28-cu.yd. concrete mixer with new belt distributor discharge, and a Burton locomotive.

STANDARD OIL CO., (Indiana) Chicago —Working model of oil-pumping outfits and samples of road oil.

ASPHALT ASSOCIATION, New York— Road models, charts, samples and photographs.

BROWN HOISTING MACHINERY CO., Cleveland, Ohio — No. 2 crane with 30-ft. boom; creeper treads.

FATE-ROOT-HEATH CO., Plymouth, Ohio—Plymouth gas locomotive, 3½ to 7 tons.

OSHKOSH MFG. CO., Oshkosh, Wis.— 14-cu.ft. concrete mixer with chute, "tank tread" traction and force feed lubricator.

WARREN BROS. CO., Boston—Samples of bitulithic pavement.

BARBER-GREENE CO., Aurora, Ill. — Bucket loader and belt loader.

PARKER MOTOR TRUCK CO., Milwaukee —Truck with dump body and hydro hoist.

GOOD ROADS, New York—Magazines.

ELGIN SALES CORP., Elgin, Ill.—Literature on motor-driven street cleaning machines.

PIONEER ASPHALT CO., Lawrenceville, Ill. Samples asphalt filler and expansion joints.

AMERICAN CITY, New York—Magazines.

ENGINEERING & CONTRACTING, Chicago—Magazines.

PUBLIC WORKS, New York — Magazines.

SMITH ENGINEERING WORKS, Milwaukee — Model of Telsmith rock breaker.

ENGINEERING NEWS-RECORD, New York—Magazines and books.

EUGOL MOTOR TRUCK CO., Chicago— Truck with Giant gravity dump body.

DUNN ROAD MACHINERY CO., Conneaut, Ohio — Road-finishing machine with auxiliary strike-off.

DUNN WIRE CUT LUG BRICK CO., Conneaut, Ohio—Model of 10-ft. roadway of brick laid with bituminous filler, without filler, and with cement filler.

HOLT MFG. CO., Peoria, Ill.—10-ton standard caterpillar tractor, 5-ton tractor with a bulldozer and snow-plow attachment and a 2-ton model.

LAPLANT-CHOATE MFG. CO., Cedar Rapids, Iowa — 6-cu.yd. bottom dump wagon.

RUSSELL GRADER MFG. CO., Minneapolis—Elevating graders.

J. D. ADAMS & CO., Indianapolis, Ind. — Adams adjustable leaning wheel graders.

BAKER MFG. CO., Springfield, Ill. — "Baker-Maney" self-loading scraper.

AUSTIN-WESTERN ROAD MACHINERY CO., Chicago—Tandem 7-ton gas roller; 10-ton gas roller with scarifier attachment; 10-ton standard steam roller; one Western-Aurora crusher, scarifier, Austin "Rip Snorter," a motor-driven street sweeper, Western No. 20 blade grader, Austin culverts, road-making tools and working models of crushers, graders and screening plants.

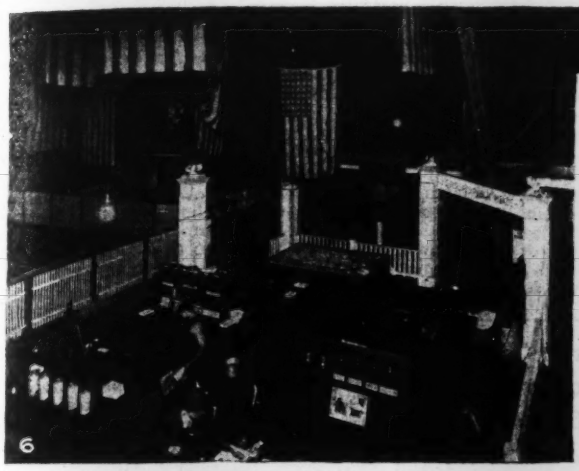
H. P. ANDRESEN & CO., Chicago — Bituminous Road repair outfits.

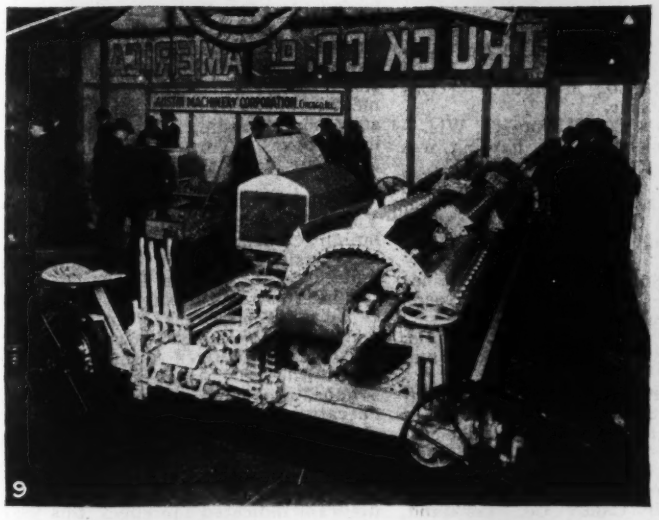
LITTLEFORD BROS., Cincinnati, Ohio— Tar kettles.

REPUBLIC SALES CORP., Alma, Mich. —Trucks with hand hoist, hydraulic

Manufacturers' Exhibits at Good Roads Show

A Few of the Individual Exhibits, Good Roads Show





6. Testing Apparatus and "Rock Map," U. S. Bureau of Public Roads. 7. Educational Booth of The Asphalt Association. 8. Lakewood Paver with Distributor Belt Discharge. 9. Austin Rotary Subgrader. 10. Bucket Loader with Positive Feed Pickup (Austin)

hoist and maintenance truck with Roots spring scraper mounted under chassis.

WOOD HYDRAULIC HOIST & BODY CO., Detroit — Trucks with horizontal and vertical hydraulic hoist dump bodies.

BLAW-KNOX CO., Pittsburgh, Pa. — Steel storage bin, sectional steel handy house, "Dreadnaught" bucket, road forms, rotary gravity dump body and miniature models of clamshell buckets.

CHARLES HVASS & CO., INC., New York—Complete asphalt plant, oil distributor and a 1½-yd. material spreader.

FOUR WHEEL DRIVE AUTO CO., Clintonville, Wis. — Three-ton truck with dump body.

AUTO-CAR CO., Ardmore, Pa.—Trucks with dump bodies, 1-, 2-, and 5-ton capacity, and 106¾ lb. crankshaft driven by electric fan 5 ft. away.

PAWLING & HARNISCHFEGER CO., Milwaukee—Corduroy 50-hp. gas shovel equipped also with skimmer scoop boom, 50-hp. double drum gas hoist.

CHAIN BELT CO., Milwaukee—Track-laying type 21-cu.ft. paver, 28-cu.ft. building mixer and 7-cu.ft. Rex paver.

LEE TRAILER & BODY CO., Chicago—Lee 4 D dump body on Ford chassis, 5-ton trailer and dump bodies.

NOVO ENGINE CO., Lansing, Mich.—Novo engines with hoists, air compressors, diaphragm and force-feed pumps, new 4-cylinder engines, 15 and 35 hp.

MILWAUKEE LOCOMOTIVE CO., Milwaukee — Locomotives, gear driven four-speed.

NORTH-WEST ENGINEERING WORKS, Green Bay, Wis. — Locomotive crane and tractor.

RANSOME CONCRETE MACH. CO.—Dunellen, N. J. — 21-cu.ft. paver, crawler traction, 4-cu.ft. power mixer and new 1-cu.ft. building mixer.

LOCOMOTIVE CRANE CO. OF AMERICA, Champaign, Ill.—New model C gasoline locomotive crane.

KEYSTONE DRILLER CO., Beaver Falls, Pa. — Keystone excavator with new drop-bottom ditcher attachment.

BYERS MACHINE CO., Ravenna, Ohio —Steam revolving crane, crawler traction and auto crane with semi-crawler traction.

GEORGE D. WHITCOMB CO., Rochelle, Ill.—Six-ton positive gear drive locomotive and cut-away view of clutch and three-speed transmission.

ASPHALT PAVEMENT RETREADING CO., Chicago—Asphalt pavement retreader.

THE T. L. SMITH CO., Milwaukee, Wis. — 21-cu.ft. paver and half bag Mixerette.

FOOTE CO., INC., Nunda, N. Y.—21- and 14-cu.ft. pavers.

AUSTIN MACH. CORP., Chicago—21-cu.ft. paver, tamper and finisher, new subgrader, cube, and Hex mixers, traction crane with clamshell, new grip-wheel bucket wagon loader and multi-pedal backfiller.

KOPPEL INDUSTRIAL CAR & EQUIPMENT CO., Koppel, Pa.—Industrial cars, track and batch box.

MONARCH TRACTORS, INC., Watertown, Wis.—Monarch industrial tractor with snowplow attachment.

L. P. GREEN, Chicago — Power drag scraper.

EQUIPMENT CORP., OF AMERICA, Chicago—Rebuilt machinery.

MARCH-CAPRON CO., Chicago—21-cu. ft. mixer for central mixing plant.

BALDWIN CHAIN & MFG. CO., Worcester, Mass. — Steel and malleable chain and Westland friction clutch.

THE OWEN BUCKET CO., Cleveland, Ohio—Grab bucket.

STROUD & CO., Omaha, Neb.—Photographs of elevating graders and dump wagons.

BLACK & DECKER MFG. CO., Baltimore —Electric drill and loadometer.

HIGHWAY TRAILER CO., Edgerton, Wis.—Steel trailer and side-dump body.

FREDRIC GREER, Chicago — Two-wheeled steel trailers.

THEW SHOVEL CO., Lorain, Ohio — Photographs of various models of shovels.

F. J. LEWIS MFG. CO., Chicago—Asphalt paving and roofing specimens.

THE BARNES MFG. CO., Mansfield, Ohio — The Barnes quadruplex pump, centrifugal and diaphragm pumps.

AMERICAN CASTING CO., Birmingham, Ala. — Cast-iron culvert, drain and sewer pipe.

MARTIN-PARRY CORP., Chicago—Steel dump bodies.

COLUMBIAN STEEL TANK CO., Kansas City, Mo.—Steel dump body and gas tank.

THE OSGOOD CO., Marion, Ohio—Engine for Model 18 Osgood ¾-yd. revolving steam shovel, swing engine and parts.

WISCONSIN MOTOR MFG. CO., Milwaukee—Three models complete 4- and 6-cylinder gas motors.

CHRIS D. SCHRAMM & SON, INC., West Chester, Pa. — Air compressors and pumps.

DAVID WHITE CO., Milwaukee—Surveying and drawing instruments.

CHICAGO STEEL TAPE CO., Chicago—Tapes, rods, engineers' and contractors' instruments.

TRUSCON STEEL CO., Youngstown, Ohio—Truscon highway products, flat sheet reinforcement and hy-rib lath.

Products of 185 Manufacturers Exhibited at Good Roads Show, Chicago

NATIONAL PAVING BRICK MFG. ASSN., Cleveland—Literature on paving brick.

R. F. CONWAY CO., Chicago — Gilsonite asphalt paints, joint fillers and plastic cement.

MUNICIPAL & COUNTY ENGINEERING, Indianapolis—Magazines.

THE TEXAS CO., New York—Literature Texco asphalt products.

HEIL CO., Milwaukee—Steel gravity dump bodies with hydro hoists.

CONCRETE STEEL CO., New York — Full line of Havemeyer reinforcing products, bars, ties, spacers, beam saddles and separators, chairs and curb bars.

ELECTRICAL & SPECIALTY SUPPLY CO., Chicago—Mushroom street traffic light.

DOMESTIC ENGINE & PUMP CO., Shippenburg, Pa.—Gasoline pumping outfits, diaphragm pumps, hoists and power units.

TURBINE SEWER MACHINE CO., Milwaukee—Sewer cleaners.

THE MAXON CO., Milwaukee — Concrete road finisher.

TITAN TRUCK CO., Milwaukee, Wis.—Subgrade trucks for batch hauling, wet mix, asphalt, gravel or grading.

WAUKESHA MOTOR CO., Waukesha, Wis.—Truck and tractor motors.

REO MOTOR CAR CO., Lansing, Mich. —"Speed Wagon," gravity dump and hoist bodies.

ROOT SPRING SCRAPER CO., Kalamazoo, Mich. — "Michigan" good roads maintenance scraper.

ATTERBURY MOTOR CAR CO., Buffalo, N. Y.—Motor trucks, dump bodies and hydro hoists.

BARBER ASPHALT PAVING CO., Philadelphia—Iroquois road roller, samples of Trinidad and Bermudez Lake asphalt.

LE ROI CO., Milwaukee—Truck, tractor and construction equipment engines.

THE PHILIP CAREY CO., Lockland, Cincinnati—Elastite expansion joints.

WESTERN WHEELED SCRAPER CO., Aurora, Ill.—Elevating graders, plows, scrapers, dump wagons, batch bodies and contractors' machinery.

CLARK TRUCKTRACTOR CO., Buchanan, Mich.—Trucks and tractors.

WIARD PLOW CO., Batavia, N. Y.—Contractors' plows.

G. A. SCHACHT MOTOR TRUCK CO., Cincinnati—Worm-drive motor trucks.

MANUFACTURERS' RECORD, Baltimore —Magazines.

THE STOUGHTON TRUCK CO., Stoughton, Wis.—2½- and 3-ton dump trucks.

GENERAL MOTORS TRUCK CO., Pontiac, Mich.—Three 5-ton dump trucks.

THE HUG LUMBER & CONSTRUCTION CO., Highland, Ill.—Truck turntable and blade-type of subgrader.

OLIVER CHILLED PLOW CO., South Bend, Ind.—Contractors' plows.

WARNER MFG. CO., Beloit, Wis. — Heavy duty trailer reversible bottom and new side dump types.

RICE EQUIPMENT CO., Chicago — Fordson tractor, industrial type.

FIELD BODY CORP., Chicago—New 1½-yd. dump body for Ford truck chassis.

INDIANA MOTOR TRUCK CORP., Marion, Ind. — 2½-ton dump truck equipped with Heil hoist.

GOOD ROADS MACH. CO., Kennett Square, Pa.—Grader and scarifier.

ALLIS-CHALMERS MFG. CO., Milwaukee — Gasoline tractor, 4-wheel type.

HADFIELD-PENFIELD STEEL CO., Bucyrus, Ohio—New crawler traction attachment for rear drive on Fordson truck, Hp. 40 gasoline crawler tractor, new Henneuse design.

SHAW-ENOCHS TRACTOR CO., Minneapolis—Gasoline tractor with scarifier attachment.

ROGERS TRACTOR & TRAILER CO., Albion, Pa.—The Rogers four-wheel-drive tractor.

AVERY CO., Peoria, Ill.—"One Man Road Razer," a new combined tractor and road blade grader.

F. W. WILSON MACHINERY CO., Chicago—General line of contractors' supplies.

KOEHRING CO., Milwaukee — New 20-ton locomotive crane, 45-ft. boom, multiplane traction treads, equipped with either drag line or orange peel bucket. Three types of paving mixer, including 21-cu.ft. road building machine with adjustable delivery dump bucket, 7-cu.ft. alley paver and 7-cu.ft. Dandy mixer with batch hopper for sidewalk and building work.

KISSEL MOTOR CO., Hartford, Wis.—Road truck with three-batch compartments. Model of 60-yd. sand and stone storage and loading hopper, with measuring boxes. Turntable with circular track for motor trucks on roadbuilding work.

INTERNATIONAL MOTOR CO., New York—Two types of 2½-ton Mack road-building truck, one with a 10-ft. wheelbase designed to turn on a subgrade and the other with a 12-ft. wheelbase for use with a turntable. A 900-gal. capacity Mack-Cressy road sprayer mounted on a Mack chassis.

PORTLAND CEMENT ASSOCIATION, Chicago—Educational exhibit of photographs, diagrams and model showing operations in the construction of a concrete road. Statistics indicated an equivalent of 18-ft. concrete road constructed in 1921 of 5,864 miles and a total to date of 22,495 miles. Another diagram indicated the effect, this year, of the fall letting of highway contracts. From September to December, 1921, inclusive, more than $3,000,000 worth of work was awarded each month as against between $1,000,000 to $2,000,000 each month during the previous year.

WHITE CO., Cleveland — End-dump 5-ton road-building trucks and 2-ton batch truck with two compartments.

SEIBERT-MILLBURN CO., Columbus, O.—Lee concrete road finisher.

MALIS POWER & SUPPLY CO., Chicago —Surplus army tarpaulins.

General Contractors' Convention

(*Concluded from p. 166.*)

Associated General Contractors of America, (1) Express their sympathy and accord with the purpose of the investigations in progress in New York and Chicago; (2) instruct their committee on ethics to prepare such a "statement of principles governing the relations of contractors with owners, other contractors, workman, manufacturers and dealers that the illegal practices disclosed by the investigations named shall be eliminated."

Building Practices Discussed

Two leading subjects came up for consideration at the sectional meeting of the building contractors: (1) Procedure and practice of members undertaking work within the jurisdiction of a local chapter other than that of which they are a member; and (2), incomplete and partial plans by architects and engineers requiring contractors to complete plans and assume responsibility for design properly the duty of the architect and engineer.

Discussion of the first subject was crystallized in the following rules adopted by the convention in general session:

1. Whenever a member assumes any contractual operations in territory within the jurisdiction of a local chapter other than the one in which he holds membership, it shall be his duty before employing labor in the various crafts, to first ascertain from the local chapter, the prevailing wage scale.

2. That it shall be the duty of such member to offer employment to the various crafts at a rate of remuneration not more than the prevailing local wage scale as ascertained from the local chapter.

3. That in case of difficulty in securing a sufficient force of men due either to the magnitude of the work undertaken, or to a prevailing scarcity of skilled men, the member conducting such operation shall request a special meeting of the members of the local chapter having jurisdiction, and upon such meeting being called, shall lay the matter before it.

4. That it shall be the duty of the local chapter to immediately investigate the difficulties complained of and to attempt in good faith to relieve such difficulties by whatever methods seem best under the circumstances.

5. That it shall be the duty of the contractor from outside the territory to conform to the suggestions of the local chapter in attempting to relieve the conditions complained of, without interrupting the prevailing wage scale.

6. That should the method suggested by the local chapter fail to relieve the situation, the outside member and the local chapter, or either of them, shall place the entire matter before the Executive Board of the Associated General Contractors for its ruling, and such ruling shall be final.

7. That any member who shall refuse to abide by any such ruling of the board, after due notice thereof, in writing, shall be subject to discipline as provided for by Section 7, of Article II of the Rules of Procedure.

No official action was taken with respect to the second subject but individual members cited many examples and condemned the growing practice of architects and engineers of issuing partial plans for the contractor to develop. It was contended that the practice was the outcome of competition and price cutting to secure commissions by shifting the burden of designing details and of guaranteeing safety of design for construction, to the contractor.

Discussion by the roads section related to reduction of surety company premiums, standard materials contracts, and standard methods and equipment for highway construction. It was summarized in a series of resolutions to this effect:

1. That a reduction in the cost of highway construction can be effected through a reduction by the surety companies of the premiums now charged for contract bonds.

2. That a reduction in the cost of highway construction can be effected through the working out of a standard form of material contract which will be more binding upon both parties and that the A.G.C. is requested to appoint a committee to confer with representatives of the various material associations of material producers, looking to the joint formulation and adoption of such a form of contract.

3. That a reduction in highway construction cost can be achieved through the working out of a greater degree of standardization of methods of construction and types of equipment in highway construction. In a recent editorial, the *Engineering News-Record* stated that during three years of intensive activities, highway constructors had made practically no progress in the matter of standardization of equipment and methods of construction. We ask the national body to accept this challenge upon the part of the highway contractors of America and appoint a committee to study the question of standardization of equipment and construction methods.

4. Since recent scientific investigations have disclosed the fact that hardness of coarse aggregates in concrete pavements is not as vital to the construction of durable pavements as was formerly thought. It is the opinion that a reduction in highway construction costs can be secured through a lowering of the present requirements of most highway specifications as to hardness of coarse aggregate, which will permit the opening up of additional sources of supply and it is requested that the A.G.C. take this matter up with the American Association of Highway Officials with the object of lowering the minimum requirements.

Open Shop and Open Markets Advocated

It was brought out in the discussions in all of the sectional meetings that restrictions in the labor and materials markets were placing a heavy burden of unnecessary cost on construction, and as the result of separate actions by the sections the convention in general assembly took formal action as follows:

Since the growth of trade associations has caused the establishments of trade agreements and practices which hinder economic distribution and restrict the right of individuals to buy certain construction materials in an open wholesale market, and necessitate the payment of a differential to a local distribution for no economic service rendered.

1. This Association is unqualifiedly in favor of an open market for all materials needed in the construction industry, and is resolutely opposed to all combinations, whether of manufacturers or contractors, whereby prices are fixed on the market or controlled in favor of any particular interest and against the interests of the general public; and

2. This association is equally opposed to any combination whether of labor unions or of contractors, whereby the right to seek or furnish employment is limited to any particular class of persons, members of any association, organization or union.

Program for 1922

Plans for the association activities in 1922 adopted by the management include 45 subjects, of which the following are of particular interest to engineers: (1) Conference of construction cost accountants to develop a standard system of cost accounting; (2) Develop standard estimating forms for builders and highway contractors; (3) Conference on standardization of equipment; (4) Study and begin standardization of construction methods; (5) Complete an equitable rental lease; (6) Formulate and issue a code of ethics for contractors and relations with subcontractors. A budget of $175,000 for the work of the association for 1922 was voted.

Transportation Chief Topic At Am. Soc. C. E. Meeting

Waterways, Highways, Railways Reviewed, and Recommendations for Their Betterment Made

Transportation by waterway, highway and railway was discussed thoroughly and certain recommendations as to how the various systems of transport could be bettered were made at the sixty-ninth annual meeting of the American Society of Civil Engineers in New York City, Jan. 18-20. Though such discussions formed the technical part of the program, alternative features which included trips to engineering works in and near the city, and social features, including a dinner-dance and a smoker.

Water Transportation—The first session, unfortunately sparsely attended on account of the rival excursion, was devoted to "Water Transportation," which the speakers interpreted to mean ocean transportation. The three addresses by Dr. Emory R. Johnson, R. H. M. Robinson and Winthrop L. Marvin, in effect were pleas for some sort of a shipping subsidy. Samuel O. Dunn, of *Railway Age*, argued in favor of closer relationships of ship and rail haulage, and for such rates as would permit the railways to compete with the Panama Canal in transcontinental carriage.

Railway Transportation — Three of the four major elements that go to make up a railroad system were discussed on the afternoon of Jan. 18. The speaker representing each element gave his review of the situation and recommended specific action to alleviate the general industrial depression in so far as the railroads figure. The first speaker was Howard Elliott, chairman of the Board, Northern Pacific R.R. The second represented the operating employees—William N. Doak, vice-president, Brotherhood of Railway Trainmen, of Washington. The third was Col. F. A. Molitor, chairman of the Board of Economics and Engineering of the National Association of Owners of Railroad Securities. All agreed that the railroads were in a precarious condition and further rate reductions might throw the roads into financial ruin or return them to gov-

ernment ownership, all three of the speakers soundly denouncing such procedure.

Mr. Elliott paid a tribute to the farsighted men who had created such an immense transportation system, but asserted that in the present crisis the public saw only "the penny of failure" in the railroad administration and entirely passed over "the dollar of profit" feature. He asserted that the railroads were indispensable to the great growth that the country had experienced in the last fifty years, but that they had not prospered accordingly. He believed that the utmost care should be exercised in reduction of freight rate charges in order to bring about a further general deflation in prices. A decrease in the wages of railroad operatives, he said, should precede any further decrease in transportation charges.

In the solution of the railroad problem, Mr. Elliott pointed out, the engineer might contribute (1) a lessening in the tractive effort of rolling stock; (2) a decided improvement in terminal facilities; (3) an improvement in water and fuel stations; and (4) a reduction to the minimum of the dead weight of rolling stock. The elimination of waste all through the various transportation branches were also considered a job in which the engineer could co-operate.

For Settling Disputes

Mr. Doak reviewed the various methods by which decisions in railroad disputes had been arrived at and assigned to each class, in his opinion, deficiencies and virtues. The greatest amount of mutual benefit, he said, had been derived from bi-partisan voluntary boards of adjustment. Conciliation, mediation and arbitration had all served their purposes and were efficacious in certain instances, but the voluntary bi-partisan board had so far proven its superior merit.

As suggestions which would materially clear up difficulties usually existing between the transportation employer and employee, he offered the following:

1. That agencies be established for the prompt appointment of mediation, arbitration and conciliation boards.
2. That bi-partisan boards should be established to decide disputes the three foregoing boards were unable to agree upon.
3. That a fair trial be given the railroad Labor Board and that this latter body dispose of cases which the foregoing bodies would be unable to solve.
4. That agencies be established for determining the exact truth regarding transportation conditions and that such truth be disseminated to the general public through reputable publications.
5. That both transportation employees and employers unite in a campaign of education which would reveal the true facts in connection with the railroad situation.

These suggestions, if carried out, he felt would eliminate a great deal of the animus exhibited in newspaper editorials and in private and public conversation—animus that was based on half truths which he characterized as being far worse than whole untruths.

Col. F. A. Molitor, representing the security holders, deplored the present lack of credit of railroad securities asserting that the causes contributing to the decline in their value were in addition to the Adamson law, (1) a refusal to increase rates in 1916; (2) government operation of the railroads with the attendant loss in operating efficiency; (3) the raising of the wages in July, 1920; (4) the proposed abolition of the 6 per cent return provision on net operating income; (5) the extreme deliberation exhibited by Congress and other governmental bodies in the adjustment of railroad claims.

Molitor Offers Remedies

As remedies to the present situation he suggested (1) discontinuation of general freight reductions; (2) adjustment of railroad labor compensation to the level of living costs; (3) the incorporation of the Railroad Labor Board within the Interstate Commerce Commission; (4) the continuance of the 6 per cent return provision as a fair percentage for bond holders of railroad securities; (5) and a strict financial supervision of union organizations and the elimination of radicalism from the ranks of such organizations.

Col. Molitor asserted that not only would the report his committe is about to make declare for certain economies in operation and terminal facilities, but would suggest or provide financial means for their accomplishment.

Sessions on Roads

Highway Transportation—The three sessions devoted to highway engineering, financing and bonding, administration and motor vehicle control developed papers and discussions mostly general in character. Pointing out the extent of expenditure in the last two years in highway construction and the lag of construction behind the use of motor vehicles, T. H. MacDonald, Chief, U. S. Bureau of Public Roads, called for a development of state highway engineering organizations and of courses in engineering schools directed more particularly to the training of highway engineers. With 10,000 engineers now engaged in highway work, the developing program, he stated, called for an accretion of 1,000 to 1,200 annually to be supplied by the engineering colleges.

The specific organization of a state highway engineering department was presented as represented by the Pennsylvania Highway Department by Col. W. D. Uhler, chief engineer. Education and efficiency of inspectors were laid down as the prime essentials of good construction. In financing highway development, bond issues were deprecated by J. N. Cole, Massachusetts State Department of Public Works, who urged a "pay-as-you-go" construction policy in all states.

E. A. St. John and E. E. Lunt, speaking for liability insurance companies defended high premiums as warranted by the high risks of business. A disclaimer of especial hazard was entered by F. S. Greene former state highway commissioner of New York, who urged legislation proceeding for self-insurance by the state. Motor vehicle taxation, motor vehicle traffic control, and the relations of highway to other transportation systems were discussed.

Akron to Choose New City Manager Soon

Applications for the position of city manager of Akron, Ohio, are being received by a special committee of the City Council consisting of Joe O'Neill, W. R. Palmer and J. P. Frisby. The salary is $7,500 a year in place of the $10,000 received by William J. Lamb, who filled the position until the first of the year. Several applications from non-residents have been received, but it is thought unlikely that a non-resident will be appointed if a satisfactory Akron man can be secured.

Extra Meetings To Be Held by Am. Soc. C. E.

Board Direction Holds Quarterly Session—Other Action Taken—Convention Date Unsettled

At the regular quarterly meeting of the Board of Direction of the American Society of Civil Engineers, held in New York City during the annual convention last week, action was taken whereby two more meetings of the society will be held during the year, in addition to the convention and the annual meeting. The first of these is to be held in Dayton on April 5 and 6 and the subject to be discussed will be "Flood Control." The second will be held during October some place on the Pacific Coast, probably San Francisco, and "Water Power Problems" will form the chief topic of discussion. It is probable that these extra meetings will be held in April and October each year and symposia upon the most live engineering topics will be discussed.

The place and date of the society's annual convention have not yet been decided upon, though it is probable that it will be in Maine either late in June or early in July.

The Board also approved a plan whereby there shall be paid to each of the local sections $1 per member per year for the maintenance of such local sections. Such a plan it is believed will greatly stimulate membership campaigns among the local sections.

The acting secretary of the society was instructed to request all local sections to consider the question of the society's becoming a member of the Federated American Engineering Societies, and report the sentiment before the next meeting of the Board of Direction on April 3.

Approval was given the formation of student chapters at the following institutions: Carnegie Institute of Technology, Georgia School of Technology, Lafayette College, Lehigh University, Montana State College, University of Missouri, Ohio State University, and Virginia Polytechnic Institute. Formation of a local section of the society at Toledo, Ohio, was also approved.

The following committees were announced:

Executive Committee.—John R. Freeman, chairman; Robert Ridgway, vice-chairman; A. P. Davis, George H. Pegram, George S. Webster.

Publications Committee.—John R. Freeman, chairman; J. J. Yates, C. W. Hudson, R. L. Humphrey, C. E. Grunsky.

Public Relations Committee.—Baxter L. Brown, chairman; Leonard Metcalf, Onward Bates, G. R. Putnam, A. H. Markwart.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Convention, Cleveland, Ohio, Feb. 13-16.
AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; Annual Convention, Chicago, March 14-16.

The **Rochester Engineering Society** will hold its quarter-centennial dinner on March 18. At the dinner, five prizes, awarded by individual members of the society, will be presented to the winners of the competition for the best papers on engineering topics. The competition is open to all members of the society. Papers should reach the secretary on or before noon of Feb. 20. There will be a first prize of $50, second prize, $25; third prize, $15; fourth prize, $10; fifth prize, $5. Further information regarding the competition may be obtained from the secretary.

PERSONAL NOTES

P. F. CAMPBELL was elected borough engineer of Lilly, Pa., at a recent meeting of the council.

D. A. TOMLINSON, who has been for the past two years connected with the structural bureau of the Portland Cement Association, has been made manager of the newly organized railway bureau. The purpose of the new bureau is the compilation and presentation to railroad officials of authoritative data on railroad uses of concrete.

JOHN P. KENNEDY, civil, mining and mechanical engineer with the Pennsylvania railroad has been appointed a member of the Board of Public Utilities, Los Angeles, Cal.

A. C. WOOD, hydraulic engineer with the Oliver Iron Mining Co., Duluth, Mich., has resigned to accept a similar position with the Chile Exploration Co., Chile, South America.

H. W. COLEMAN has been appointed director of the department of Public Works, of the city of Albany, Ga.

C. E. SHEARER and W. W. WESSELL are the engineer and contractor members respectively, of a commission recently named to revise the building code of Memphis, Tenn.

THE CAHILL-VENSANO CO., contracting engineers of San Francisco, have dissolved partnership. All existing contracts will be completed. John R. Cahill and Edward G. Cahill have formed an engineering firm under the name of Cahill Bros. and H. C. Vensano will engage in the contracting business.

PATRICK H. FITZPATRICK has been appointed superintendent of streets for the city of Bridgeport, Conn., for a term of two years.

JAMES A. MCELROY, city engineer of Bridgeport, Conn., has been reappointed for a term of two years. He will also take over the duties of the superintendent of construction, which office was abolished in December.

HENRY GORDON HINKLE, for four years city manager of Altoona, Pa., has accepted a position of city manager and chief engineer of Columbus, Ga.

L. L. PEARSALL, formerly division engineer for the state highway department Kentucky, has been made chief locating engineer.

HARRY S. RIDDELL, former supervising engineer of the Happy Valley Irrigation District, has been made resident engineer for the Tule Irrigation District and the Baxter Creek Irrigation District.

JOHN S. GALVIN, secretary of the state highway commission of California, has been appointed a member of the state civil service commission.

GEORGE W. BORDEN has been made chief engineer of the department of highways for the state of Nevada. Mr. Borden has been acting chief since the resignation of C. C. Cottrell last September.

JOHN J. COX, engineer manager of the Washtenau county (Michigan) road commission, has resigned and A. R. Bailey of the firm of Bailey and Atwell has been appointed to take his place.

CHARLES WHEATLEY of the Georgia State Highway Department has been made city engineer of Americus, Ga.

EDWIN F. WENDT, consulting engineer, has opened an office in Washington, D. C., for the general practice of engineering in connection with valuation, financing, consolidation and regulation of railroads, telegraphs, water lines and other common carrier properties. He was formerly a member of the engineering board, Bureau of Valuation, Interstate Commerce Commission, in charge of the Eastern District. Mr. Wendt was graduated from Geneva College in 1888 and received the honorary degree of doctor of science in 1913. After graduation he entered the service of the Pittsburgh and Lake Erie R.R. at Pittsburgh, Pa., and was, until he entered government service, engineer in charge, in various capacities, of construction and maintenance work. He was a member of the New York Central Lines engineering committee, 1907-1913; member of the commission to inspect the government railroad in Alaska in 1917; president of the American Railway Engineering Association in 1913; and president of the Washington Society of Engineers in 1918.

OBITUARY

LEWIS S. SADLER, commissioner of the Pennsylvania State Highway Department, died at his home in Carlisle Jan. 20 after a brief illness. Mr. Sadler was born in Carlisle in March, 1874. He was a member of the class of 1895 at Yale and later graduated from the Law School of Dickinson College. He practiced law several years and became interested in political and financial matters in Pennsylvania. During the war he was executive officer of the Pennsylvania Committee of Public Safety and the Council of National Defense, giving his services without salary. He was appointed commissioner of the state highway department in January, 1919. During the three years since he assumed direction of the department, nearly 1,400 miles of main highway have been constructed and nearly $75,000,000 spent on road construction and maintenance. Geo. F. Biles, deputy commissioner, becomes acting commissioner pending the selection of a commissioner by the governor.

EUGENE D. LAFLEUR, chief engineer of the Canadian Department of Public Works, died suddenly at his home in Ottawa. He was in charge of the surveys of the Georgian Bay Canal in 1904-1905 and was appointed to his late position immediately after the completion of the survey.

MICHAEL ANGELO CLARKE, pioneer engineer and contractor died recently in San Francisco at the age of 90. He was born in New York State but most of his work has been done in the west to which he went in 1850 to build the state prison at Folsom, Cal.

William H. Bradley, Gas Engineer

William H. Bradley, chief engineer of the Consolidated Gas Co., of New York, for 36 years, died suddenly of heart failure on January 18, at the age of 84.

Mr. Bradley was born in New Haven, Conn., in 1838 and received his education in the common schools of that city. He served for a time in the mechanical department of a large manufacturing establishment in New Haven, coming from there to the Continental Iron Works, in New York, as construction engineer. That company, which carried out a number of large government contracts, in 1862 built Ericsson's *Monitor*, which subsequently defeated the ironclad *Merrimac*, and Mr. Bradley, who took an active part in the building of the vessel, had the opportunity of contributing to its success by valuable criticisms and suggestions. At the close of the war he went to western Pennsylvania where he had become interested in oil discoveries, but he returned in 1870 to the Continental Iron Works, taking charge of the gas plant and gas holder departments.

One of the first gas plants built under his supervision was that of the Municipal Gas Works, in West 44th St., New York. After the completion of this plant Mr. Bradley became engineer for the Municipal Gas Light Co., at the same time acting as engineer for the Metropolitan Gas Light Co. The Consolidated Gas Co. was incorporated in 1884, and two years later Mr. Bradley became chief engineer of the company, remaining in this position until his death.

After an extended trip to Europe, where he studied gas plants in various countries, Mr. Bradley made a survey of the gas-supply situation of New York, which convinced him that the time would come when gas for the city would have to be manufactured outside of Manhattan Island. This conclusion resulted in the construction of the largest gas plant in the world, at Astoria, Long Island, a plant constructed in every detail according to Mr. Bradley's designs. Only ten days before his death Mr. Bradley had visited the Astoria plant where he saw the newly completed 15,000,000-cu.ft. gas holder put into operation, the second holder of this capacity built under his plans.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Lumber Business Starts Recovery After Holiday Slump

Reports from various mill centers to the American Wholesale Lumber Association indicate a slow recovery in lumber demand for the first week after the usual holiday recession. Production was at 68 per cent of normal, new business at 59 per cent of normal and shipments at 62 per cent. Yellow pine orders exceeded fir orders for the first time since Dec. 3, 1921. On the Pacific Coast both rail and export orders fell off, although moderating weather permitted rail shipments in excess of the last of November, 1921.

truction Outlook for Spring 60 Per Cent Better Than a Year Ago

Construction Contracted for in Last Quarter of 1921 Probably Totaled $650,000,000

IMMEDIATE prospects for spring construction can best be estimated by examining the figures for contracts awarded in the last quarter of 1921. The total for this period was $300,000,000, as against $267,000,000 in October, November and December of 1920. Placing these two totals on a 1913 purchasing basis (by applying *E. N.-R.*'s Construction Cost Index Number covering the two periods) gives $174,000,000 and $105,000,000, respectively, as the comparative constructive values of contracts let in the last quarter of 1921 and 1920. This means that the *volume* of construction actually in immediate prospect is 66 per cent in excess of last spring's volume.

Table I gives the money value of engineering construction work awarded in the last quarter of 1921 on all classes throughout the country for the six groups of states, according to the regular weekly arrangement in Construction News. The next to the last column gives the totals on each class of construction for the entire country, and these may be compared with the 1920 totals shown in the last column. In this comparison it must be borne in mind that the construction dollar in the last quarter of 1920 was worth only 39 cents, as against 58 cents in the same period of 1921.

It must also be understood that *Engineering News-Record* publishes in Construction News only those projects which exceed specified minimum costs: $150,000 for commercial buildings, $40,000 for industrial works, and $25,000 for public improvements. Furthermore, no account is taken of ordinary residential construction which probably amounts to nearly 50 per cent of total construction.

Table II presents F. W. Dodge's statistics of residential contracts awarded in December, 1921, in the Northeastern quarter of the United States. These figures include prices of all apartments, flats and tenements, all dwellings, barns and farm buildings, dormitories and private garages. The last column gives the ratio of residential construction in each district to the total construction reported for that district.

Accepting $300,000,000 as the value of important engineering contracts awarded in the United States in the last half of 1921, the total value of all construction in the country awarded in this period will aggregate approximately $650,000,000.

TABLE I.—VALUE OF CONTRACTS LET IN THE UNITED STATES IN LAST QUARTER OF 1921 AND 1920

	New England	Middle Atlantic	Southern	Middle West	West of Miss.	Western	Total for Last Three Months 1921	Total for Last Three Months 1920
Water-Works	$40,000	$7,607,909	$168,665	$3,650,159	$4,497,335	$420,399	$16,384,467	$14,370,827
Sewers	34,000	1,803,809	305,662	3,152,888	1,826,222	957,380	8,079,961	15,590,635
Bridges	50,000	516,135	516,945	1,680,452	957,312	919,146	4,639,990	6,098,853
Excav. & Dredging	.....	157,765	217,000	261,431	1,359,143	.....	1,995,339	2,335,059
Streets and Roads	2,000,000	20,773,540	11,500,952	12,491,001	13,245,978	6,119,408	66,130,879	36,171,020
Industrial Works	2,890,000	9,670,141	2,263,350	11,630,406	4,106,678	2,032,567	32,593,042	73,421,349
Buildings	15,313,753	44,829,207	13,199,790	58,198,066	20,318,722	2,939,378	154,798,916	83,731,560
Miscellaneous	400,000	3,778,446	554,080	1,768,439	546,834	3,065,865	10,113,664	24,655,879
Federal Gov't	574,749	1,159,684	220,859	1,331,913	151,915	1,098,315	4,537,435	10,835,816
Railways	.....	3,867,138	50,000	50,000	.....	.....	.....	.....
Total	$21,302,502	$94,163,774	$28,997,303	$94,214,755	$47,010,139	$17,552,458		
					Grand Total		$299,273,693	$267,220,998

TABLE II.—RESIDENTIAL CONTRACTS LET IN DECEMBER, 1921

District	Number Projects	Value	Per Cent of Total Construction
Boston	785	$17,358,700	65
New York	1,141	44,071,500	70
Philadelphia	594	12,097,100	36
Pittsburgh	661	8,640,100	38
Chicago	806	16,382,400	35
Minneapolis	249	2,346,900	27
Total	4,236	$100,896,700	50

Labor Trouble Grows More Serious in Chicago

Citizens' Committee Issues Booklet Naming 1,000 Contractors Who Support Landis Award

The resignation of Thomas S. Kearney, president of the Chicago Building Trades Council, and the election in his place of William Curran of the plumbers' union and a leader in opposition to the Landis award is taken as a direct throwing down of the gauntlet to the citizens' committee to enforce the Landis award. Mr. Kearney, while militant, was inclined to live up to the arbitration proceedings. Mr. Curran, whose ascendancy is said to have the backing of "Big Tim" Murphy, a labor leader recently convicted of conspiracy to rob the United States mails, is almost sure to precipitate strikes and cessation on all building work where non-union men are employed. In fact slugging parties have already begun.

The citizens' committee is optimistic and has issued a booklet containing nearly 1,000 names of contractors and sub-contractors who have pledged themselves to work in accordance with the Landis award. The committee has announced that it is prepared to furnish contractors or mechanics in the following trades which have been declared open shop. Carpenters, plumbers, sheet-metal workers, lathers, cement finishers, hoisting engineers, fixture hangers, slate and tile roofers and composition roofers.

Decision in the injunction proceedings brought by the carpenters' union to restrain the work of the citizens' committee is expected this week.

Funds above $1,000,000 in amount, much of it in small amounts by the general public, have been subscribed toward the $3,000,000 figure deemed necessary to finance the committee.

Westinghouse Electric Receives $2,000,000 Japanese Order

The Westinghouse Electric International Co. announces that it has received from its Japanese agent, Takata & Co., an order from the Daido Electric Power Co. of Japan for electrical apparatus for two large hydro-electric plants. The total value of this order is about $2,000,000. These hydro-electric plants are to form a part of a super-power system for the Tokio district, similar to that now under construction for the area between Boston and Washington. The current is to be transmitted at 154,000 volts.

Work has been started at the plant of the Westinghouse Electric & Manufacturing Co., Pittsburgh, Pa., on the largest single order for electrical transformers ever placed, according to an announcement made by officials of that company. The order was received through the company's Japanese agents, and the contract calls for thirty-four transformers averaging 9,400 kva. The transformers are to be installed in a super-power system in the industrial district about Tokio, a super-power zone similar to that now under consideration for the area between Boston and Washington.

Eleven months will be needed to complete the order.

Trend of Business

Bonds — The principal issue was the $30,000,000 Southern Ry. Co. development and general mortgage 6½s, due 1963, at 94½, to yield 6.9 per cent. Municipals firm but inactive. Copper and sugar issues stronger because of higher prices.

Money—General stiffening owing to withdrawal of balances by interior institutions. Call loan rates moved from 3½ per cent to 6 and then to 4½@6, averaging 5. Time funds at 4½, instead of 4 as in preceding week. Easier market expected soon.

Textiles—Generally better tone.

Iron and Steel—Steel Corporation operating at about 40 per cent capacity, independents at about 30 per cent. Prices unchanged for over a month.

Wholesale Prices in December stood at an index 149 for all commodities, the same as for November, according to the Bureau of Labor Statistics.

Lower Prices in 1921 than in 1920 reduced the gross sales of Sears-Roebuck & Co. from $254,595,059 in 1920 to $178,014,981 for 1921. The net loss is $16,435,469, as against a net profit of $11,746,670 ($10.65 per share) in 1920.

Industrial Expansion and Building in Baltimore

Active industrial growth took place in Baltimore during 1921, despite the severe business depression. The city had almost $11,000,000 of capital added for new industries and expansion of existing plants. Moreover, there is at present a demand for structures of various kinds, resulting from an accumulative shortage and an influx of labor to man the new industries, of which some will be ready for operation in the early part of 1922. These conditions forecast a building program of even larger proportions in the next few years.

Among the new plants already announced for erection in 1922 are Lyon, Conklin & Co., American Oil Co., Patuxent Clay Products Co., National Cooperage Co., Cyl-Lap Products Co., Adamantex Brick Co., Hampden Laundry & Ice Manufacturing Co., and the Rasin-Monumental Fertilizer Co. at Curtis Bay. The building program of the Standard Oil Co. will be continued, as will also that of the Prudential Oil Corp. and the Red "C" Oil Co., Sherwood Brothers Co., and the U. S. Asphalt Refining Co. The directors of the Bethlehem Steel Corp. have added another $65,000,000 to that company's expansion program at Sparrows Point.

Among hospital buildings are to be counted that of the woman's clinic of Johns Hopkins Hospital, an 8-story service building for the Church Home and Infirmary, the Union Memorial Hospital, a continuation of the large University of Maryland Hospital program and the Municipal Hospital for Contagious Diseases. Five large apartment houses are planned, a 5-story garage and at least one office building. The Public Improvement Commission will continue its program of municipal improvement during 1922, $25,000,000 to $30,000,000 being available for its various activities.

Wages Down 16.1 Per Cent Since the Peak

Study of Key Industries — Building Trades Workers Cut 17 per Cent— Materials Men, 18

A tabulation of average wage reductions during 1921, with the approximate numbers of workers and establishments affected has been compiled by the J. L. Jacobs Co., Chicago, and is reproduced here. The digest summarizes reports from 1,026 establishments and industrial groups, and shows average wage cuts of 16.1 per cent for over 5,000,000 workers. Since the start of deflation in 1920 the cost of living, as calculated by the United States Bureau of Labor Statistics and other agencies, has declined about 20 per cent.

In the building trades of 183 cities where building trades workers received cuts 8.2 per cent of the total reduced wages less than 10 per cent; 41.5 per cent of the total reduced wages between 10 and 14 per cent; 12 per cent made reductions between 15 and 19 per cent; 26.3 per cent reported cuts of from 20 to 24 per cent and 12 per cent reduced wages over 25 per cent.

The more important instances in which building trades wages have been reduced since the peak include those of from 12½ to 20 per cent in Seattle; 25 in Fall River and in Danbury, Conn.; 24 in Philadelphia; 10 to 20 in Newark, N. J., Omaha, Neb., Fort Wayne, Ind., and Lynn, Mass.; 10 to 15 in San Diego, Cal.; 14 in Warren, Pa.; 15 to 20 in Des Moines, Iowa; 20 in Worcester, Mass., in Minneapolis and St. Paul, Minn., in Saginaw and Bay City, Mich., and in Memphis, Tenn.; 10 to 16⅔ in Boston, Mass.; 10 to 35 in Pittsburgh, Pa.; 20 to 25 in Milwaukee, Wis., and in Toledo, Ohio; 7½ in San Francisco, Cal.; from 10 to 36 in Chicago, Ill., through the present decision of Federal Judge Landis; 12½ to 20 in New Orleans and in Dayton; 17 in Cleveland; approximately 20 in Detroit; the California metal trades, including some 25,000 workers were reduced 10 per cent; and 35,000 sheet and tin plate workers between Pittsburgh and St. Louis received a like reduction of 10 per cent. The County building trades of Westchester County, arbitrated the wage adjustment and some 10,000 workers received a reduction of 11 per cent.

Iron and steel workers, both of the United States Steel Corporation and the independents, have in most cases received three reductions and the wages have been brought down to the level of May, 1917, the reductions being approximately from 30 to 40 per cent from the peak.

Among the public utilities, wage reductions reported show that of 161 organizations, 35 reduced wages 5 to 9 per cent; 57 reported reductions of from 10 to 14; 31 from 15 to 19; 26 from 20 to 24; and 12 over 25 per cent. Some of the larger street railways reporting reductions include those in the cities of New York, Philadelphia, Brooklyn, Boston, San Francisco, Detroit, Cleveland, Pittsburgh, Denver, Los Angeles, Seattle, Albany, Indianapolis, Buffalo, Milwaukee, Omaha, Topeka, Council Bluffs, Salt Lake City, Mobile, Ala., Fort Wayne, Syracuse, N. Y., Newark, N. J., and other metropolitan New Jersey cities.

A number of municipalities and state organizations made wage reductions from 5 to 20 per cent, affecting particularly highway and street employees, firemen, policemen and some officials. The outstanding reduction was that in the Federal government in which a reduction of from 10 to 20 per cent was made for the 68,000 civilian workers of the United States Navy Department.

By deducting the 1,879,000 railroad and express employees who received an average wage reduction of 12½ per cent, the average reduction for the other 1,024 groups and establishments is approximately 18.1 per cent.

WAGE REDUCTIONS IN 1921 BY INDUSTRIES
Compiled by the J. L. Jacobs Company, Chicago.

Industry	Number Establishments or Groups Reporting	Estimated Number Employes Affected	Average Per Cent Wage Reduction
Meat Packing	18*	200,000	25.5
Cotton Manufacturing	27*	217,000	24.9
Hosiery & Underwear Mfg.	8	7,000	24.3
Leather Manufacturing	8	15,500	22.0
Woolen Manufacturing	26	100,200	20.0
Car Bldg. and Repairing	12	15,600	19.6
Mining	26	137,000	19.5
Iron and Steel	101*	433,800	19.2
Building Materials Mfg.	16	6,800	18.3
Electrical Manufacturing	6	75,500	18.2
Rubber Goods Mfg.	13	12,500	17.9
Boot and Shoe Mfg.	39	78,500	17.5
Building Trades (Cities)	183*	490,000	17.0
Men's Clothing Mfg.	7*	100,000	16.7
Paper Manufacturing	22	24,000	16.6
Public Employment	58	111,500	16.5
Silk Manufacturing	25	31,500	16.2
Public Utilities	161	144,350	14.8
Shipbuilding	20	109,300	14.8
Express Employes (R. R.)	1*	50,000	12.5
Railroad Employes	1*	1,829,000	12.5
Miscellaneous	248	866,300	16.4
Totals and Average	1,026	5,055,350	16.1

*Entire Group or Industry Included.

Grand Trunk Places Rail Order

The Grand Trunk R.R. has placed an order covering its rail requirements for 1922, closing recently orders with the Dominion Iron & Steel Co., and with the Algoma Steel Corporation, orders aggregating 29,000 tons. The Dominion Iron & Steel received an order for 15,000 tons for production at its Sydney plant. The Grand Trunk rail orders added to the Canadian National Railway's recent placing of 40,000 tons in equal shares with the Dominion and Algoma Companies brings the total for the two systems to 69,000 tons.

Bids Desired on Big Jobs

Among the projects on which bids are either asked or will soon be called in Construction News, pp. 31@39, are the following:

A hotel for Los Angeles, $10,000,000.

A 20-story bank and office building for Cleveland, $10,000,000.

A library for Philadelphia, $3,000,000.

A hospital for St. Louis, $1,000,000.

A waterworks project for Newport Beach, Cal., $250,000.

A dam for Columbus, Ohio, $3,000,000.

Large Contracts Let

Among this week's announcements of contracts awarded in Construction News, pp. 31@39, are the following large projects: A 5-story hotel in Los Angeles, Cal., to Milwaukee Bldg. Co., Wright & Callender Bldg., $1,250,000; a street and road development for Tallahassee, Fla., $1,853,946; a 15-story apartment in New York City under supervision of R. Candela, New York, $1,500,000.

Urges Amnesty for Trusts

In a recent speech before the Building Trades Employers' Association and the General Contractors' Association of Massachusetts in Boston, Samuel Untermyer, counsel to the Lockwood legislative committee on housing, which is investigating New York building conditions, urged amnesty for violators of the Sherman anti-trust law who make full disclosure of existing illegal agreements and prosecution of those who do not meet the amnesty conditions.

Mr. Untermyer doubted the possibility of the suppression of such trade conspiracies, but he asserted an endeavor should be made to do so before resort was had to compromise methods. The qualification which he placed upon such an agreement would be that amnesty should not be granted in any case where there had been ruinous competition, coercion or other form of oppression of competitors, or where the combination had involved the commission of a criminal offense other than that of violating the anti-trust law.

Twenty-One in Soil Pipe Trade Are Indicted

An indictment charging ten individuals and eleven corporations, members of the Eastern Soil Pipe Manufacturers Association, with price fixing and violation of the Sherman anti-trust law, was made public recently by the United States attorney for the Southern District of New York. The allegation is made that the defendants conspired to restrain trade through an agreement to control the sale of soil pipe.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of January 5; the next, on February 2.

Steel Products:	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$2.63	$3.50	$4.00	—$2.63	$2.91	$3.50	$3.10	—$3.60	$4.00
Structural rivets, 100 lb.	3.50	5.00	5.50	3.43	3.90	4.25	4.50	4.00	6.50
Reinforcing bars, ¾ in. and larger, 100 lb.	2.53	3.20	3.50	2.68	2.81	+3.42½	2.75	3.75	2.75
Steel pipe, black, 2½ to 6 in. lap, discount	61%	57.65%	45%	57%	61.9-5%	44%	53.7%	+53%	35.10
Cast-iron pipe, 6in. and over, ton	47.30@48.30	45.00	48.30	44.10	47.80	52.00	50.00	—44.00	60.00
Concreting Material:									
Cement without bags, bbl	2.30	2.55	2.55	1.97	2.24	2.90	2.84	2.94	3.10
Gravel, ¾ in., cu.yd.	1.75	1.85	2.00	2.00	1.50	2.50	2.25	1.50	1.50
Sand, cu.yd.	1.00	1.25	2.00	2.00	.50	1.10	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.75@1.85	2.00	2.93	1.60	2.25	3.50	2.25	3.00	2.10
Miscellaneous:									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	49.00	35.00	34.00	+44.00	38.00	50.00	32.00	19.00	.....
Lime, finishing, hydrated, ton	16.99	19.00	25.00	18.00	29.00	30.00	22.00	27.00	+26.00
Lime common, lump, per bbl.	3.00@3.49	1.50	2.75	1.40	1.40	2.95	1.75	2.75	11.00
Common brick, delivered, 1,000	18.40	9.00	12.65	11.00	15.00	14.00	15.50	14.00	16.00
Hollow building tile, 4x12x12, block	Not used	.0675	.13	.0821	.0752	.08	.12½	.10	.08
Hollow partition tile 4x12x12, block	.11120	.0675	.13	.0657	....	.10	.14½	.11	.....
Linseed oil, raw, 5 bbl. lots, gal.	+.75	+.80	.93	+.79	.84	+.93	.83	+.86	—.82
Common Labor:									
Common labor, union, hour	.75	.35	.....	.72½	.40	.50@.55	.62½	.50@.60	.....
Common labor, non-union, hour.	.....	.20	.35@.45	.35@.40	.40	.35@.40	.56¼	.50	.20@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations are delivered except tiles, which are "on trucks." Common lump lime per 280-lb. net; both lump and hydrated quoted f.o.b. cars New York. Sand gravel and crushed stone are quoted alongside dock. Cement and steel pipe delivered to contractors on job. Gravel ready mixed $2 per cu.yd.

Chicago quotes hydrated lime in 50-lb. bags; common lump line per 180-lb. net.

Minneapolis quotes on fir instead of pine. Brick and hollow tile delivered. Cement on cars. Gravel, sand and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to contractors in yards at San Francisco. Lumber price is for No. 1 fir, common.

Seattle quotes on Douglas fir instead of pine. Common lump lime per 180-lb. net.

Montreal quotes sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone, on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 95 cents). Bag change is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net.

Changes Since Last Week

Pittsburgh mill price of $1.50 per 100 lb. on structural steel continues in effect. Steel shapes are quoted in the Chicago warehouses at $2.63 as against $2.88 and in Seattle at $3.60 as compared with $3.85, one week ago. Steel prices, generally, seem steadier now than at any time during the last year.

Long leaf yellow pine is quoted in Chicago at $44 as against $43 and in Denver at $50 as compared with $45 per M. ft. b.m., last week.

The Interstate Commerce Commission has ordered a reduction in freight rates on hardwood lumber. This schedule will become effective not later than Mar. 6, 1922, and will reduce the scale to 7@11c. per 100 lb. above the rates prevalent in 1920, before the general increases went into effect. The various yellow-pine lumber associations are appearing before the Interstate Commerce Commission this month to present their case for lower rates on yellow pine. No rate reduction on this type of lumber is anticipated for the next two months. Leading lumber manufacturers anticipate higher prices by Mar. 1, 1922.

Good demand for paint materials, for the approaching spring season, has prompted an advance of 2c. per gal. in raw linseed oil (5 bbl. lots) in New York and Denver; 3c. in Chicago and 7c. in Seattle.